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NATIONAL DAM INSPECTION PROGRAM. FISHING CREEK DAM (NDS MD 16).--ETC(U)
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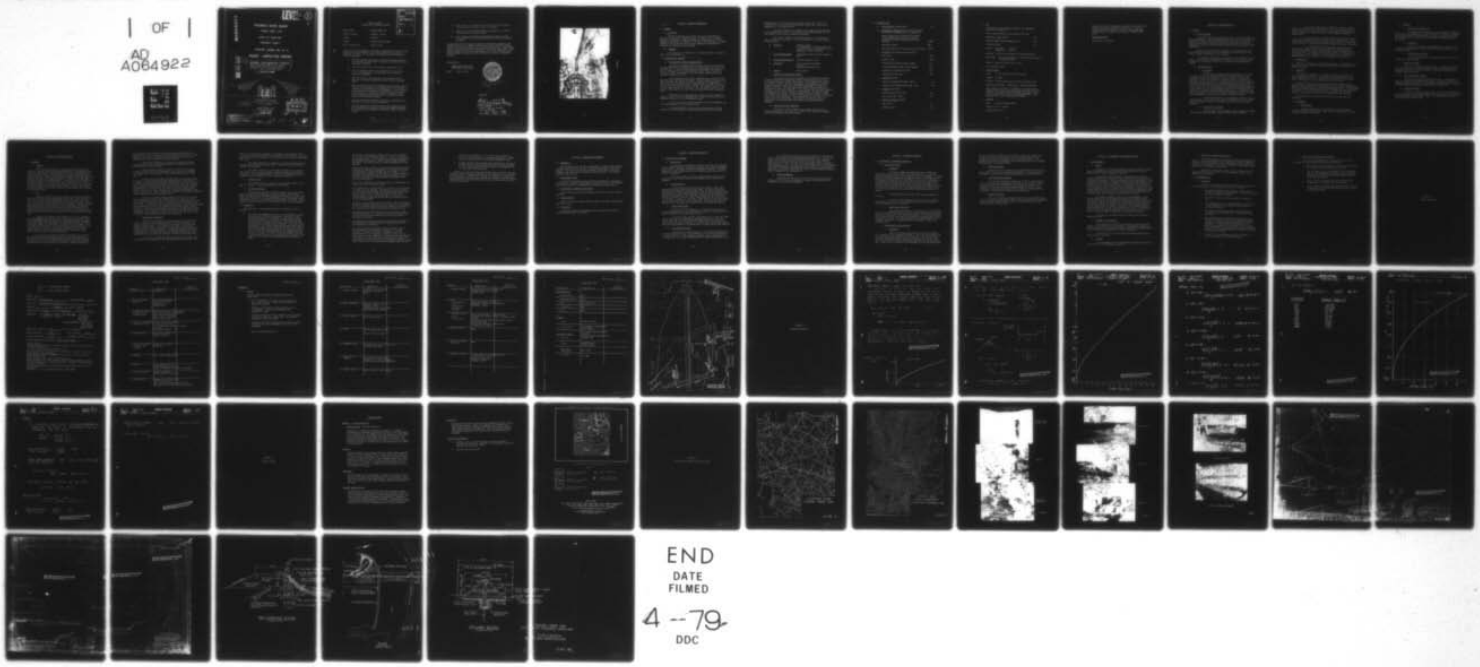

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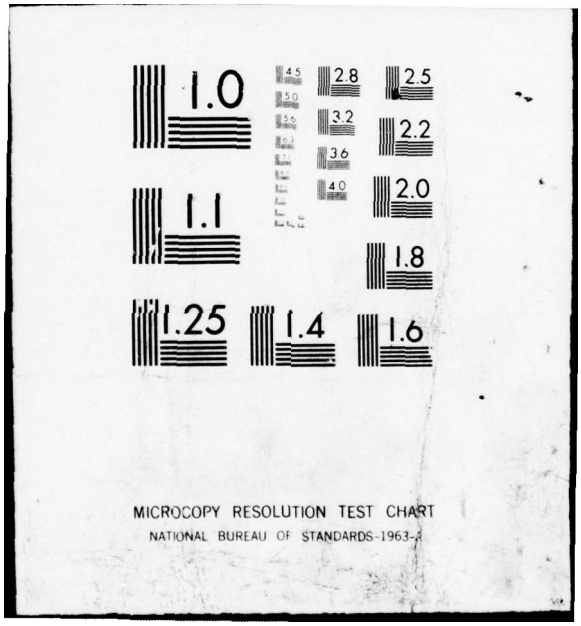
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LEVEL II (1)

POTOMAC RIVER BASIN

FISHING CREEK DAM

STATE OF MARYLAND

FREDERICK COUNTY

INVENTORY NUMBER NDS MD. 16

PHASE I INSPECTION REPORT

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(6) NATIONAL DAM INSPECTION PROGRAM. Fishing Creek Dam (NDS MD 16). Potomac River Basin, Frederick County, State of Maryland. Phase I Inspection Report.

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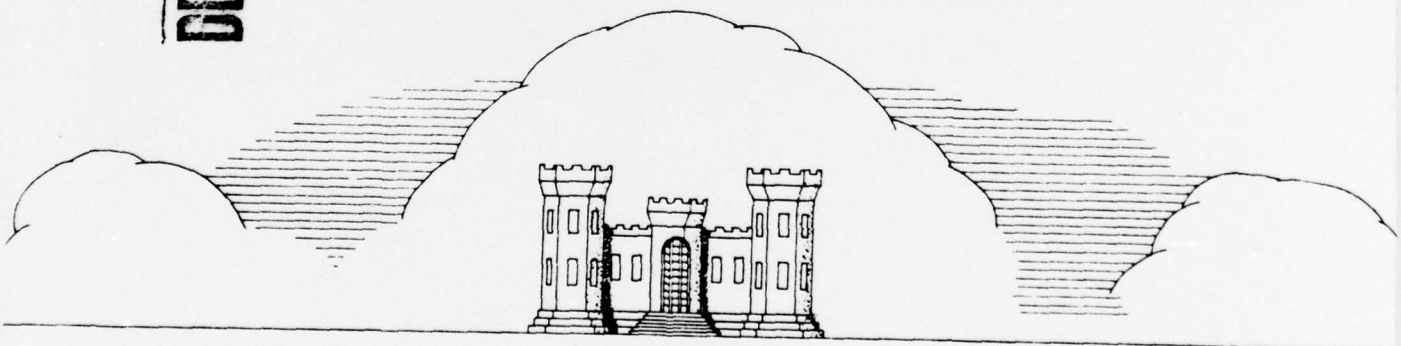

Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland

by
BERGER ASSOCIATES, INC
CONSULTING ENGINEERS
HARRISBURG, PA

(11) JULY 1978

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	FISHING CREEK DAM
State & State No.	Maryland - MD.16
County:	Frederick
Stream:	Fishing Creek, Potomac
Date of Inspection:	June 22, 1978

Based on the past performance, available engineering data and the visual inspection, the dam appears to be in poor condition and in need of immediate attention. The following recommendations are presented for action by the owner:

1. That the spillway discharge and reservoir storage capacity be evaluated and steps taken to improve the present seriously inadequate condition.

2. That the break in the outlet tunnel be repaired at once.

3. That the apparent break in the foundation drain from the toe of the embankment to the spillway outlet channel be located and repaired.

4. That the cracks in the spillway outlet channel slabs be repaired to prevent undermining of these units during high flows.

5. That new studies assess the discharges at the outlet, from the toe drain and the source of discharge through the spillway channel wall downstream from the embankment. A record should be maintained of the quantity and turbidity of the seepage at all locations. These data should be evaluated by the owner's engineering consultant and if conditions indicate, remedial action should be taken.

6. That deficiencies or symptoms of distress or malfunction be attended to as soon as they are detected.

7. That the heavy tree and brush growth on the downstream slope of the embankment be removed to reduce the danger associated with potential overtopping and to improve access for observations.

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8. That a plan for improved access across the spillway outlet channel and to the intake tower be developed.

9. That the top of the dam embankment be brought to a uniform elevation over its entire length.

10. That a formal surveillance and downstream warning system be developed to be used during periods of heavy or prolonged rainfall.

In accordance with the Corps of Engineers' evaluation guidelines, the spillway capacity is inadequate for passing the PMF (Probable Maximum Flood) or 1/2 PMF peak inflow without overtopping the dam. Calculations indicate that it will pass only 18 percent of the PMF peak inflow. These facts, together with the near overtopping of the dam in 1936 and 1955 and the slight overtopping in 1976, indicates a seriously inadequate spillway.

Submitted By:

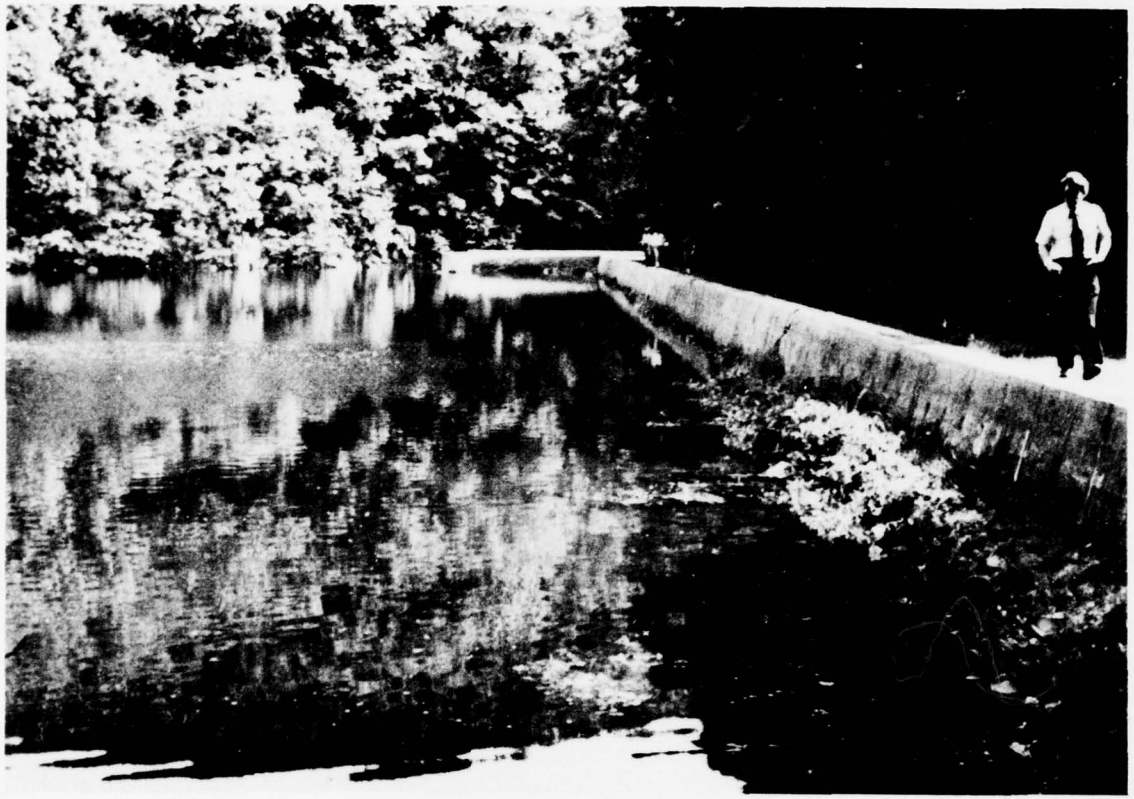
BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

Date: July 31, 1978

Approved:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 31 Jul 78



OVERVIEW

ABSTRACT

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-237 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States. Phase I Inspection and Report is limited to a review of available data, a visual inspection of the dam site and the basic hydraulic calculations to determine the adequacy of the spillway.

~~B. Purpose~~

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

ABSTRACT

A. Description of Dam and Appurtenances

In 1924, the Fishing Creek Dam was constructed to impound 60 million gallons (MG) of surface water for water supply use by the City of Frederick. In 1933 the Fishing Creek Dam embankment was raised 4.3 feet to elevation 719.3 and the spillway raised 5 feet to elevation 715.0 to provide an additional 17 MG of storage, bringing the total reservoir capacity to 77 MG.

The existing dam is an earth embankment approximately 49 feet high above the original stream bottom. The dam contains a concrete core wall to prevent the passage of water through the earth embankment. At the north end of the dam a 70 foot long spillway is founded on rock. It has a 5 foot high concrete "ogee" section. The elevation of the crest of this "ogee" section is 715.0 feet. The non-overflow section of the dam is 12 feet wide at the top, 584 feet long and the top is elevation 719.3.

Reference to the 1923 drawings of this facility, Appendix D, Plates VI and VII show the embankment as a rolled fill with a 3H to 1V upstream slope and a 2H to 1V downstream slope.

A concrete core wall extends through the entire embankment and to a varying depth into the natural ground.

A stonefilled drain trench is located downstream from the concrete core wall parallel to the dam axis and with an exit trench

perpendicular to this trench near the center of the dam. This exit trench drains to a rockfill toe drain which extends the length of the embankment at its downstream toe.

The intake structure is located in the reservoir lake area and is accessible only by boat. It contains three control devices; two 16-inch valves and one 30-inch diameter sluice gate.

The conduit leading to the outlet structure is a concrete 6-foot x 5-foot arch top tunnel. A 12-inch diameter C.I. pipe is located in this tunnel.

B. Location: Frederick County
U.S. Quadrangle, Catoctin Furnace, Md.
Latitude 39°-31.5', Longitude 77°-27.7'
(Appendix D, Plates I and II)

C. Size Classification: Intermediate (236 acre-feet, height 49 feet)

D. Hazard Classification: High (See Section 3.1.E)

E. Ownership: City of Frederick Maryland
City Hall
Frederick, Maryland 21701

F. Purpose: Water supply

G. Design and Construction History

The original dam at this location was designed by Norton Bird & Whitman of Baltimore, Maryland in 1923 and was constructed in 1924. To satisfy additional storage requirements, the dam breast and spillway were raised in 1933. The near overtopping of the embankment in 1936 prompted studies to modify the spillway and embankment to improve the safety of the dam. Two such studies were made by Whitman Requardt & Associates of Baltimore, Maryland. Plans and specifications were prepared in 1952, but the construction was not carried out. The dam was nearly overtopped again in 1955. Whitman Requardt prepared a report in 1960 and a permit was obtained to lower the spillway and increase the elevation of the top of the embankment. This modification was not made. As a result, the dam today reflects the structure as modified in 1933. Maintenance of the appurtenant factilities has been carried out as required.

H. Normal Operating Procedures

The dam is used for domestic water supply for the City of Frederick, Maryland. The level of the water in the reservoir is regulated by valves downstream from the dam.

1.3 PERTINENT DATA

A.	Drainage Area (square miles)	7.3
B.	Discharge at Dam Site (cubic feet per second) For hydraulic computations, see Appendix B.	
	Maximum known flood at dam site in October 1976, estimated at four feet of head on spillway plus slight overtopping at right abutment	2,000+
	Warm water outlet	None
	Spillway capacity at top of dam pool Elev.719.3	2,250
C.	Elevation (feet above mean sea level)	
	Top of dam	719.3
	Spillway crest	715.0
	Upstream portal invert outlet conduit	675
	Downstream portal invert outlet conduit	671
	Streambed at centerline of dam	670
	Maximum Tailwater (Est.)	678
D.	Reservoir (miles)	
	Length of maximum pool (Elev. 719.3)	0.5
	Length of water supply pool (Elev. 715)	0.5
E.	Storage (acre-feet)	
	Spillway crest (Elev. 715)	212
	Top of dam (Elev. 719.3)	274
F.	Reservoir Surface (acres)	
	Top of dam	15
	Spillway crest	13

G. Dam

For general plan and typical sections, See Appendix D, Plates VI, VII and VIII.

Type: Rolled earthfill with concrete core wall.

Embankment Length (feet)	584
Maximum height above streambed (feet)	49
Top width (feet)	12

Slopes: Upstream - 3H to 1V
Downstream - 2H to 1V

Upstream: 18 inch rock facing on 9 inch gravel filter.

Downstream: Rock toe with filter - 3 feet of sand and gravel drainage blanket.

Cutoff: Concrete core wall set on rock.

Grout Curtain: None.

H. Outlet Conduit

Type: 5' x 6' Concrete arch drain tunnel.

Length: 267 feet.

Closure: 30 inch sluice gate at bottom of intake tower.

Regulating facilities - sluice gate - manually operated.

Water supply feed lines - In addition to the above outlet conduit, there is a 12-inch pipe which takes water from the reservoir for domestic use in Frederick, Maryland. Water can be taken from the reservoir at elevation 685.7 or at elevation 705.7 and is controlled by valves.

I. Spillway

Type: Uncontrolled ogee weir.

Length of weir: 70 feet.

Crest elevation: 715

Downstream channel - Rectangular, concrete lined chute, descending over channel excavated in natural rock. Concrete training walls are located at the top of the channel and masonry walls are located at the bottom at natural stream level.

J. Regulating Outlet

See Section 1.3.H above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Data Available

The initial dam was constructed in 1924. The files contain no design information. Four drawings available in the files of the Maryland Department of Natural Resources (DNR) and at the office of the owner show a general plan of the area, plan view of reservoir, sections of embankment, intake and outlet structures and profile of dam axis showing cutoff wall.

Details of design for the raising of the spillway level and the embankment elevation in 1933 are limited to three sketches in the files. Design calculations are not included.

Considerable design data and drawings for the proposed improvements in 1952 and 1960 are available. However, since neither of these designs were carried out, they are not pertinent to this inspection report.

B. Design Features

1. Embankment

The 1923 design drawings show the embankment to be made of rolled fill with a concrete cutoff wall extending from the rock foundation through the embankment to within 3 feet of the dam crest elevation of 715. The section of the dam axis shows a stepped cutoff wall base sitting on rock. At its deepest point, center of the dam, the cutoff rests at elevation 653±. The upstream slope was designed as 3H to 1V with 12-inch rip rap protection. The downstream slope is indicated as 2H to 1V. A stone filled drain trench was installed downstream of the cutoff wall and is daylighted at the toe of the embankment in a rockfill toe through a similar trench perpendicular to the dam axis and near the center of the dam. The rockfill toe appears to span the length of the embankment. The top of the dam had a width of 12 feet.

The 1933 modification to the embankment involved raising the dam breast as well as the core wall to elevation 719.3. This information is shown on a sketch in the files and is shown on Plate VIII, Appendix D.

2. Appurtenant Structures

The 1923 plans include minimum details showing the intake tower, outlet tunnel and waste canal (spillway outlet channel).

The intake structure is a reinforced concrete cylinder with an arched dome. The tower contains three control devices; two 16-inch valves and one 30-inch sluice gate. The tower is connected to the outlet structure by a 5-feet by 6-feet (inside dimension) concrete arched tunnel.

The waste-canal or spillway channel was a simple concrete slab sloping downstream with an upstream sill at elevation 710.0. The channel was 64 feet wide at the upstream end and varied to 55 feet wide at the lower end. Concrete gravity walls trained the flow in the channel.

The 1933 modification included the installation of a concrete ogee section on top of the initial sill and slab overflow, raising the spillway crest to elevation 715.0 where it remains as of this inspection. The length of the spillway crest was increased to 70 feet during the 1933 improvement. Detail sketches are in the files. Calculations are not included. Refer to Appendix D, Plate VIII.

2.2 CONSTRUCTION

There are no records of construction available. Photographs in the DNR files show that the lake was drawn down in 1976 for repairs to the intake facilities.

2.3 OPERATION

The purpose of this dam is to provide a supply of water for the City of Frederick, Maryland. This dam is one of several sources of water supplying the city. It is, however, the only dam in the system. Water is supplied to the City through a 12-inch C.I. main.

General experience is that the lake level will drop during the summer months. Maintenance of water level in the reservoir is made with pressure regulating valves located downstream from the dam. This operation has been in effect for about two years. Previously, the lake was allowed to drain to its own level without control. Attempts are now made to keep the level within 18 inches of the spillway overflow elevation.

The 30-inch gate valve can be used to draw the lake down when necessary.

2.4 EVALUATION

A. Availability

Design information for the structure as it now stands is limited to drawings and sketches. There are no calculations or design criteria available for the dam.

B. Adequacy

1. Hydrology and Hydraulics

The design data available were not sufficient to evaluate the original 1923 design nor the 1933 modification. Present calculations are based upon physical dimensions and the Corps of Engineers criteria. The records do show a concern for the inadequate discharge capacity at the spillway.

2. Embankment

Data on the design of the embankment are limited to the available design drawings. Calculations for stability analyses are not in the DNR records.

3. Appurtenant Structures

The data available for the appurtenant structures is also limited to design drawings.

C. Operating Records

There are no formal operating records. As indicated earlier, this facility is one of several sources of water supplying the City of Frederick, Maryland. The rate of flow is controlled downstream with pressure regulating valves.

D. Post Construction Changes

The dam was originally constructed in 1923. Modifications to raise the spillway and embankment were made in 1933-36 to increase the storage available for supply. Two additional modifications were proposed (1952 and 1971) neither of which were actually constructed.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The Fishing Creek Dam is in a mountain setting with heavy growth of trees and bushes on the downstream slope. The spillway chute at the left abutment is excavated into natural rock and descends to the spillway outlet channel. The channel has a natural bottom and stone masonry side walls leading to the natural stream some 200 feet downstream from the spillway. The intake structure is located in the lake about 190 feet upstream from the embankment. It houses the control valves and gate which lead to the outlet and the water supply line. The outlet structure consists of a concrete arch conduit 5 feet wide x 6 feet high. A 12-inch diameter water supply line is located in this outlet tunnel. The outlet channel is also stone lined with stone masonry walls leading to the natural stream.

B. Dam

The heavy growth of trees and brush on the entire downstream slope is the first striking observation at this dam. Trees of 30 feet to 40 feet in height with trunk diameters up to 24 inches cover the area. The presence of this cover makes it extremely difficult to observe the condition of the slope surface. Field observation indicate that the modifications made in 1933 did not raise the embankment or upstream portion of the slope to the top of the core wall as indicated on the plans (Appendix D, Plate VIII). The top of wall is at the design elevation, but the ground level on both sides of the wall is about 16 inches lower.

Seepage was observed at the downstream toe of the embankment at a point approximately 123 feet left of the outlet structure. The water discharging from this location is clear and cold and is estimated to be about 20 gpm (not measured). The material from which the water is flowing appears to be the rockfill as indicated on the plans. This discharge is flowing onto a flat area directly downstream from the toe of the embankment creating a wet marshy condition. The discharge meanders slowly overland creating other surface pondings at random until it finds its way to the stream channel.

Field discussions with the owner's representative indicates the possibility that an underground drain pipe existed between the rock toe and the spillway outlet channel and that the 1976 storm that destroyed a portion of the spillway channel wall could have disrupted and destroyed the outlet portion of this pipe. Repairs were made to

the wall and a short section of pipe was installed through the wall. This short pipe was not joined to any other pipe behind the wall. This pipe does have steady flow, however, and presumably is acting as an underdrain for the area immediately behind the wall.

Under these conditions, the initial pipe leading from the toe has no outlet thus causing the discharge to emerge at the toe of the embankment and flow overland.

Another seepage point was found at the left of the outlet structure near the toe of the embankment. The flow here is estimated to be about 5 gpm (not measured). The discharge here was also clear and cold.

A third source of leakage was identified in the outlet tunnel at a point 157 feet upstream from the downstream face of the outlet structure. Inspection of this leakage source noted a break in the floor of the tunnel located about 18 inches from the left wall. The break is about one-inch in diameter and water was spurting to a height of about 5-inches above the the floor of the tunnel. The water at its source point is clear but is rust colored at the outlet due to sediment in the bottom of the tunnel. Refer to Sketch #1, attached to the visual inspection report (Appendix A) for all seepage points.

The top of the dam is grass covered to the limit of the back of the concrete core wall which extends vertically to the top of the dam. The exposed portion of the core wall does not show any major signs of distress. The upstream slope is indicated on the plans as 3H to 1V. As the slope is under water this could not be verified. Vertical depressions were noted along the top at the embankment behind the exposed concrete core wall. The owner's representative noted that the high water, during the 1976 storm, did spill over a short section at the right end of the embankment. This indicates a low portion at the right abutment although it was not visually detectable during the inspection.

C. Appurtenant Structures

The existing spillway is a concrete ogee section 70 feet in length. Aside from some deterioration of the concrete surface, this structure appears to be in sound physical condition. There were no signs of major distress. The concrete apron below the ogee section leading to the discharge channel has numerous cracks of sufficient size to allow growth of weeds and brush. The spillway channel is excavated in natural rock. The discharge from the spillway cascades over the exposed rock to the outlet channel below. There is no stilling basin.

A steady flowing pipe was observed located in the right spillway channel wall approximately 100 feet downstream from the dam. The

source of this discharge is unknown. The owner's representative indicated that pipes were installed in this general area to improve a previous wet condition during the repair of the wall after the previously mentioned 1976 storm.

The intake structure is located in the lake area upstream from the dam, and is accessible only by boat. The gates and valves in this structure are operable.

The outlet structure, as previously described, is a concrete arch tunnel. It is in need of repair to seal the leak on the floor as indicated in the seepage discussion. The 12-inch diameter pipe running through this tunnel appears to be in satisfactory condition.

D. Reservoir Area

The reservoir area is clean with mature timber growing to the edge of the water. Special problems were not observed.

E. Downstream Channel

The downstream channel is natural mountain stream conditions, with stoney bottom and trees and brush to the edge of the channel. Summer cottages and some permanent residences are adjacent to the stream and in the flood plain. It is estimated that about 150 residences with a population of 400 to 500 persons are located along the stream. Public camping is permitted adjacent to and downstream from the dam embankment.

3.2 EVALUATION

The conditions of note observed during this inspection are as follows:

1. The steady flow seepage at the toe of the embankment is about 123 feet left of the outlet structure. Reference to the design plan Plate No. VI, Appendix D, shows a stone filled drain ditch located at the base of the embankment just downstream from the concrete cutoff wall. This trench extends nearly the entire length of the embankment. An outlet trench, perpendicular to the drain trench extends downstream from the longitudinal trench to the rockfill at the toe of the embankment. The seepage point noted during this inspection nearly coincides with the discharge point of the perpendicular drain trench on the plan. It is felt that this seepage is coming from the drain trench and is concentrated at this point. This condition is of some concern and remedial action should be taken.

The geologic investigations indicate that the rock formation in this area is the Weaverton Quartzite. Refer to Appendix C for geologic report. This formation is essentially impermeable and groundwater movement is almost entirely along fractures and joints. The fracture zone is nearly perpendicular to the dam axis.

Since the dam has a concrete core wall extending from the rock foundation up through the embankment to its surface and above, the likelihood of seepage through the dam is small. It is considered more feasible that the water is flowing through the foundation and under the wall and then upon rising is intercepted by the drain trench and ultimately discharged at the toe of the embankment.

Under these conditions, the drainage system is operating as it should, but has no controlled outlet.

The accumulation of surface water as a result of this discharge is a matter of poor grading. This problem can be relatively easily rectified by regrading the area and installing sections of drain tile or pipe to carry the water directly to the outlet channel. A more positive method is to locate the original discharge pipe and connect this to a positive outlet in the spillway channel.

2. The break in the bottom of the outlet tunnel and its associated leakage is probably again due to water flow below the foundation. The 5-inch artesian flow indicates low pressure at this point. The condition is of concern and should be repaired at once.

3. The seepage at the left side of the outlet structure cannot readily be assessed. It could be due to some flow path along the outside of the outlet tunnel in spite of the cutoffs indicated on the plan.

4. The drainage pipe along the spillway outlet channel appears to be performing its intended purpose, although the source of this discharge is not known.

5. The heavy tree and brush growth on the downstream slope of the embankment is an undesirable situation. It is very difficult to examine the slope. Although the core wall extends from the rock foundation to the top of the dam, the major concern of this condition is associated with the potential overtopping of the dam when the large trees would topple and become uprooted by the force of the overtopping discharge. This would create loss of the downstream embankment slope and would

endanger the stability of the core wall and ultimately the dam. For these reasons, it is considered important to remove the trees and brush from the downstream embankment slope.

6. Of most concern is the reported near overtopping of the dam in 1936 and 1955 and the small discharge over the right abutment in 1976. Steps should be taken to improve the embankment top to a uniformly level elevation.

Finally, the previous studies and designs (1952 and 1971) that were prepared indicate a standing knowledge of the limitation of the capacity of this facility to operate in a confident and satisfactory manner and that improvements and maintenance repairs are required. This information, together with the observed conditions combine to describe this facility as in poor condition.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

This impoundment dam is used to supplement the water supply capacity of other sources owned by the City of Frederick, Maryland. Valves are normally left open at the dam site and water flows freely to the City through a line controlled by pressure regulating valves. The operator resides at the dam site.

4.2 MAINTENANCE OF DAM

No specific maintenance program has been established. Maintenance activities are limited to those deemed necessary by the City of Frederick. The resident operator is responsible for observations and repairs.

4.3 MAINTENANCE OF OPERATING FACILITIES

Sluice gates and valves are operated at least once a year to remove sediment.

4.4 WARNING SYSTEM

There is no formal warning system in effect, although a dam operator lives at the site.

4.5 EVALUATION

The general operational procedures are acceptable except that no formal warning system is in effect.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from Maryland DNR for Fishing Creek Dam indicates no storage curve, design hydrograph, flow routing or discharge curve were contained in the file. The files contained a report which stated that the spillway could pass 2100 cfs without overtopping.

A spillway rating curve and a stage-storage curve have been developed for this report using the information in the construction drawings.

B. Experience Data

In the period since the dam has been raised in 1933, high discharges have been experienced three times. A report in the files indicates that in March, 1936 and August, 1955 the flood discharge over the spillway was approximately 2000 cfs and about 160 cfs was discharged through the sluice gate. The caretaker indicated that on October 9, 1976, the reservoir reached a level 5-inch below the top of the dam at the spillway. However, at that time, a small amount of water was coming over the top of the dam at the southern end. The sluice gate was not opened and the discharge over the spillway was approximately 1940 cfs.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event.

It was noted that the boat launching area is on the south side of the lake, which is inaccessible during flood events. Since the intake tower and sluice gate operating mechanism are reached only by boat, this would prevent opening of the sluice gate during flood events. The operating platform of the intake tower is below the top dam elevation.

D. Overtopping Potential

This dam has an overall height of 49 feet above streambed and a maximum storage capacity of approximately 274 acre-feet calculated to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (see Section 3.1.E).

The recommended spillway design flood (SDF) for a dam with the above classifications is the probable maximum flood (PMF). The PMF for this site is 12,200 cfs and the 1/2 PMF is 6,100 cfs. The spillway capacity with the water level at the top of the dam (Elev. 719.3) is about 2250 cfs or 18% of the PMF. This would indicate that a potential for overtopping exists. An estimate of the storage effect of the reservoir shows that the Fishing Creek Reservoir does not have the storage available that is necessary to pass the PMF or the 1/2 PMF without overtopping. Refer to Appendix B for calculations.

E. Spillway Adequacy

Since both the PMF and the 1/2 PMF exceed the total spillway capacity of 2250 cfs and the necessary storage, the spillway must be considered to be seriously inadequate.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observation

1. Embankment

The heavily wooded and brush cover on the downstream slope makes it difficult to observe any slope distress. As well as could be determined, there were no signs of slope or sloughage or seepage. The major seepage discharge was located at the toe of the slope near a drainage trench leading from a longitudinal trench at the foundation of the embankment downstream from the concrete cutoff wall. The flow as estimated as about 20 gpm and was clear. This flow is judged to be coming through the foundation rock formation and may be caused by backup in the broken foundation drain. Such concentrated flow at the toe is of some concern beacuse of the possibility of piping developing in the future.

The upstream slope is mostly under water and appears to be stable.

There are several depressions on the top of the embankment behind the extension of the concrete cutoff wall. The cause of these depressions was not identified.

2. Appurtenant Structures

The physical appearance of the spillway is good, although there is some deterioration of the surface where aggregate is exposed as a result of weathering. The abutments are sound. Its discharge channel has a number of slabs which are cracked and have weeds and brush growing rhrough the openings. The energy dissipation is accomplished by the discharge falling over a rough excavated rock channel. There is no stilling basin.

B. Design and Construction Data

1. Embankment

There are no design calculations or criteria available for evaluation of the embankment stability. The 3H to 1V upstream slope is a reasonable slope ratio for this type of dam. The 2H to 1V downstream is considered adequate with the presence of the concrete core wall which extends vertically through the embankment to the top of the dam. Except for the condition of overtopping, the tree and brush growth

are not considered a threat to the stability. The drain trench downstream from the core wall appears to be functioning satisfactorily although its discharge downstream from the toe needs repair. The seepage at the toe is not judged to have a serious effect on the embankment stability at the present time.

C. Operating Records

This dam is one of several water supply sources that are owned and operated by the City of Frederick, Maryland. It is the only dam in the system. There are no formal records available for this facility.

D. Post Construction Changes

This dam was originally constructed in 1923 for water supply to the City of Frederick, Maryland. Additions to the dam were made in the years between 1933 and 1936 when the spillway was raised. The concrete core wall was extended in height as well as the top of the embankment. Although several plans were developed for other additions to the dam in 1952 and 1971, they were not constructed.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 7 - ASSESSMENT AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

A. Safety

The results of the visual inspection and the subsequent hydrologic and hydraulic calculations indicate that this dam is in poor condition and in need of immediate attention.

Conclusions from the hydraulic calculations are that the spillway can pass only 18 percent of the PMF peak inflow and therefore, is seriously inadequate. The near overtopping of the embankment in 1936 and 1955 and the slight overtopping during the 1976 storm reinforce this conclusion. The heavy tree growth on the downstream slope presents a serious condition in the event the dam is overtopped. These tall trees in all probability would be toppled and uprooted by the force of an overtopping discharge with the result of loss of downstream embankment slope and support for the core wall. For this reason it is deemed advisable to remove these trees and other heavy growth in this area.

The constant seepage at the toe of the embankment, at the outlet structure and in the spillway channel do not appear to have a serious influence on the stability of the structure at the present time. The apparent broken pipe between the rock toe and the spillway outlet channel gives reason for concern since continued concentrated flow at the toe could result in piping in the future. The surface ponding of the discharge from the toe of the embankment is more of a nuisance and will be controlled when the repair to the outlet pipe from the toe is made, and the flow again is discharged to the spillway channel.

The break in the conduit is also of concern and should be repaired at once.

B. Adequacy of Information

The information in the files is limited to design plans and reports. Calculations were not available. Calculations in support of the conclusions in this inspection report are based upon physical dimensions and criteria supplied by the Corps of Engineers.

Calculations are in the file for the proposed modifications which were not exercised.

C. Urgency

It is considered that the recommended suggestions presented in this report be given immediate attention.

D. Necessity for Additional Studies

The measures needed at this time may not require entirely new studies. The plans developed in 1960 should at least be reviewed to determine their suitability to bring the spillway capacity within the criteria as established by the Corps of Engineers. Additional studies may just be an extension of this work.

The repair to the outlet conduit and the solution to the surface drainage problem at the toe of the downstream slope will be incidental to the above.

7.2 RECOMMENDATIONS

A. Facilities

In order to assure the satisfactory performance of this dam, the following items are recommended for action by the owner:

1. The spillway discharge and reservoir storage capacity should be evaluated and steps taken to improve the present seriously inadequate condition.

2. The break in the outlet tunnel should be repaired at once.

3. The apparent break in the foundation drain from the toe of the embankment to the spillway channel should be located and repaired.

4. The cracks in the spillway outlet channel should be repaired to prevent undermining of these units during high flows.

5. New studies should also assess the discharges at the outlet, from the toe drain and the source of discharge through the spillway channel wall downstream from the embankment. A record should be maintained of the quantity and turbidity of the seepage at all locations. These data should be evaluated by the owner's consulting engineer and if conditions indicate, appropriate remedial action should be taken.

6. The top of the dam embankment should be brought to a uniform elevation over its entire length.

B. Operation and Maintenance Procedures

The following recommendations are presented for action by the owner in the operation and maintenance of the dam:

1. That deficiencies or symptoms of distress or malfunction be attended to as soon as they are detected.

2. That the heavy tree and brush growth on the downstream slope of the embankment be removed to reduce the danger associated with potential overtopping and to improve access for observations.

3. That a plan for improved access across the spillway channel and to the intake tower be developed.

4. That a formal surveillance and downstream warning system be developed to be used during periods of heavy or prolonged precipitation.

APPENDIX A

VISUAL INSPECTION

CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. 16

NAME OF DAM Fishing Creek HAZARD CATEGORY High

TYPE OF DAM Earthfill with concrete core

LOCATION Frederick COUNTY, MARYLAND

INSPECTION DATE 6/22/78 WEATHER sunny-Warm TEMPERATURE 80's

INSPECTORS: H. Jongsma, R. Houseal
R. Shireman, A. Bartlett

MD. State Reps: Jeff Smith
Tom Moynahan
Jane Wagner
Dusty Moore

City of Frederick: Calvin Bartgis
Frank White
Lester Dingle
Harold Weddle

NORMAL POOL ELEVATION 715± AT TIME OF INSPECTION

BREAST ELEVATION 719.3 POOL ELEVATION 715.2

SPILLWAY ELEVATION 715.0 TAILWATER ELEVATION —

MAXIMUM RECORDED POOL ELEVATION 719.1 (1955 & 1936)

GENERAL COMMENTS:
The downstream embankment is covered with heavy brush and large trees up to 24 inches in diameter.
Top of core wall is exposed on breast of dam.
A sag and two small depressions were noticed near the center of the top of the embankment, behind the wall.
Steady seepage at toe of embankment at 123'± left of outlet structure.
Water clear and cold.
Steady seepage at left wall of outlet structure.
Steady discharge from outlet due to break in bottom of conduit 157 feet from the downstream end. Rust colored water. Extensive calcium leaching on inside of conduit.
Pipe discharging water to spillway channel downstream of the toe of the embankment.
Twelve inch C.I. pipe located inside of outlet conduit.

DAM NO. NAD 16

VISUAL INSPECTION

EMBANKMENT	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SURFACE CRACKS	None evident	
B. UNUSUAL MOVEMENT BEYOND TOE	None evident although extremely wet due to leakage at toe (see G below)	
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Unable to detect any such condition due to heavy growth of brush and large trees on downstream slope. Most of upstream slope is under water.	
D. VERTICAL & HORIZONTAL ALIGNMENT OF CREST	Vertical settlement observed as sag near the center of the embankment behind the exposed core wall. Horizontal alignment - o.k.	
E. RIPRAP FAILURES	Under water, unable to observe condition.	
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Appear to be in good condition.	
G. SEEPAGE	Yes. Refer to added notes.	
H. DRAINS	Drain trench at base of foundation behind core wall leads to downstream rock toe of embankment.	
J. GAGES & RECORDER	One weir upstream to measure inflow to reservoir.	
K. COVER(GROWTH)	Downstream - heavily wooded - trees up to 18" - 24". Top - grassed behind exposed core wall. Upstream - stone (some visible under water).	

EMBANKMENT

G. Seepage

Several seepage locations were observed during this inspection.

1. Toe of embankment, 123± left of outlet structure. Water clear and cold. Steady flow, estimated (not measured) at 20 gpm.

2. Adjacent to left wall of outlet structure at toe of embankment. Steady flow, estimated (not measured) at 5 gpm.

3. Seepage from break in outlet conduit at 157'± upstream from outlet structure. Steady flow. Not measured. Discharge is clear in tunnel.

4. Seepage from 8" pipe discharging into spillway channel from right side and downstream from the toe of the embankment.

Refer to Attached Sketch #1.

DAM NO. NAD 16

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Concrete tower located in reservoir. Access by boat.	
B. OUTLET STRUCTURE	Horseshoe shaped culvert 6' high by 5' wide. Discharging rust colored water from leak inside conduit.	
C. OUTLET CHANNEL	Stone lined channel.	
D. GATES	One 30" slide gate in tower. Two 16" valves in tower.	
E. EMERGENCY GATE	30" slide gate in the intake tower. Access by boat only.	
F. OPERATION & CONTROL	16" valves for water supply. Regulation of flow by pressure reducing valves located downstream.	
G. BRIDGE (ACCESS)	None - access to tower by boat.	

DAM NO. NAD 16

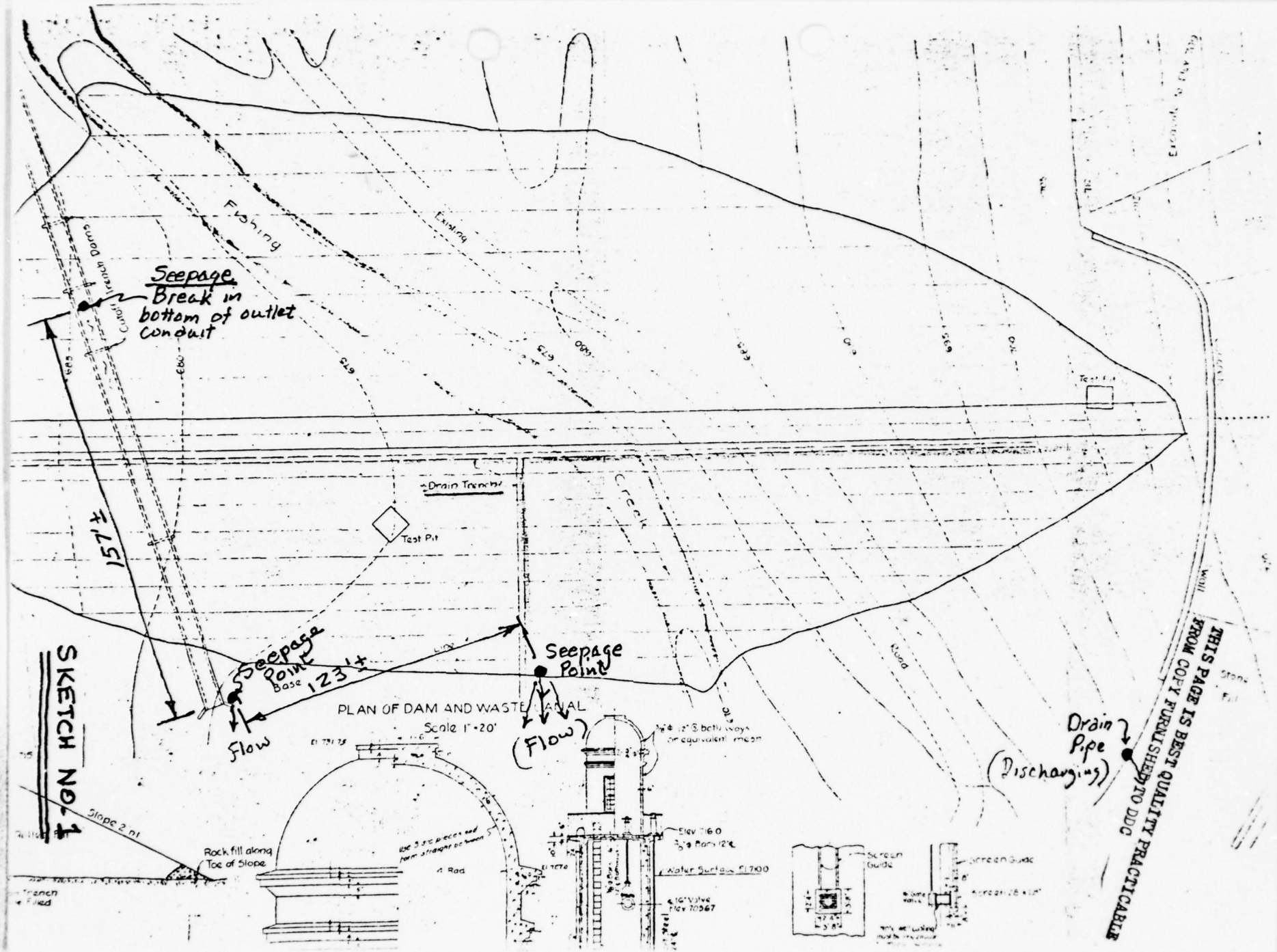
VISUAL INSPECTION

SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	Curved spillway wall on right side. Exposed rock cut on left side. Channel clear.	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Some deterioration of surface. Aggregate exposed due to weathering. Abutments - sound.	
C. DISCHARGE CHANNEL Lining Cracks Spilling Basin	Apron below spillway - concrete slabs. The slabs are cracked. Brush is growing through breaks. Discharge channel walls curved, left & right. No stilling basin. Energy dissipated over natural rock excavation in channel.	
D. BRIDGE & PIERS	None	
E. GATES & OPERATION EQUIPMENT	None	
F. CONTROL & HISTORY	Spillway raise from elevation 710 to elevation 715 in 1933. Washout in downstream channel in 1976	

DAM NO. NAD 16

VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
INSTRUMENTATION		
Monumentation	None	
Observation Wells	None	
Weirs	None below dam	
Piezometers	None	
Other	None	
RESERVOIR		
Slopes	Entirely forested	
Sedimentation	Some problem - last cleaned with repairs.	
DOWNSTREAM CHANNEL		
Condition	Stone lined below the natural spillway. Spillway channel excavated into natural rock.	
Slopes	Wooded slopes to channels edge.	
Approximate Population	400 to 500	
No. Homes	Est. 150±	


Seepage
Break in
bottom of outlet
conduit
Existing
Fishing
Drain Trench
Test Pit
Creek
157'±
123'±
Seepage
Point
Base
Seepage
Point
Flow
(Flow)
Drain
Pipe
(Discharging)
SKETCH NO. 1
PLAN OF DAM AND WASTE CANAL
Scale 1"=20'
Slope 2:1
Rock fill along
Toe of Slope
Trench
Filled
Elev 716.0
Water Surface El 700
Screen Guide
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APPENDIX B

HYDROLOGY/HYDRAULICS

BY _____ DATE _____ BERGER ASSOCIATES SHEET NO. 1 OF 8
CHKD _____ DATE _____ PROJECT D 7530
SUBJECT FISHING CREEK DAM

MAXIMUM KNOWN FLOOD AT DAM SITE

CARETAKER INDICATED THAT ON OCT. 9, 1976 THE RESERVOIR REACHED A LEVEL 5" BELOW THE TOP OF THE DAM AT THE SPILLWAY. HOWEVER AT THAT TIME A SMALL AMOUNT OF WATER WAS COMING OVER THE TOP OF THE DAM AT THE SOUTHERN END. SLUICE GATE WAS NOT OPENED.

HEAD ON WEIR = $4.3 - \frac{5}{12} = 3.88'$ $C = 3.62$

$Q = C L H^{3/2}$

$= 3.62 \times 70 \cdot (3.88)^{3/2}$

$= 1940$ CFS DISCHARGE OVER SPILLWAY

A 1960 REPORT BY WHITMAN, REQUARDT AND ASSOCIATES INDICATES THAT ON TWO OCCASIONS, MARCH 1936 AND AUGUST 1955, THE FLOOD DISCHARGE OVER THE SPILLWAY WAS APPROXIMATELY 2000 CFS AND ABOUT 160 CFS WAS DISCHARGED THROUGH THE SLUICE GATE.

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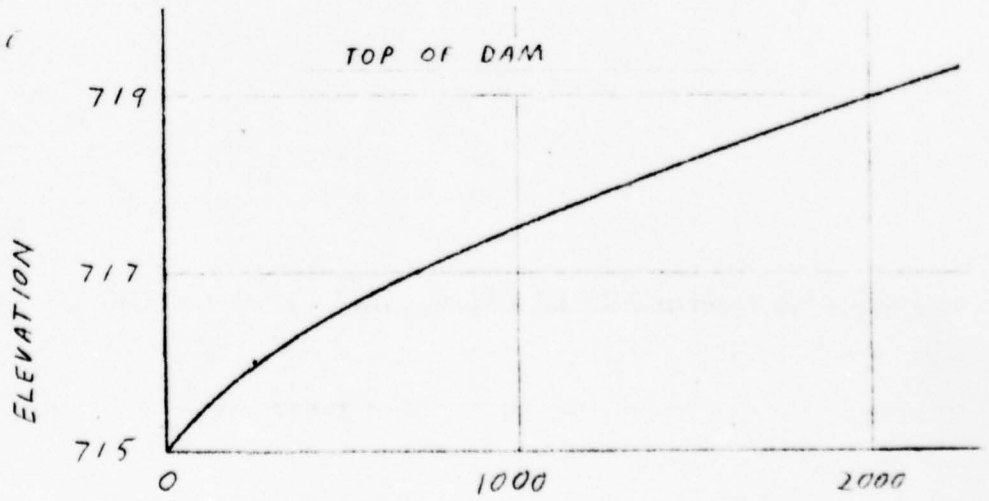
SPILLWAY DISCHARGE CURVE



BY RLS DATE 6/26/78 **BERGER ASSOCIATES** SHEET NO. 2 OF
CHKD. BY DATE PROJECT D7530
SUBJECT ELSHING CREEK DAM

DISCHARGE THRU SLUICE GATE AND DRAIN TUNNEL AT POOL ELEV. 715.0 (SPILLWAY CREST)

30" DIA. GATE OPENING

$Q = CA\sqrt{2gH}$

$= .6 \times 4.9 \sqrt{64.4 \times 38.33}$

$= 146$ CFS

USE 145 CFS

$C = 0.6$

$A = \pi D^2/4$

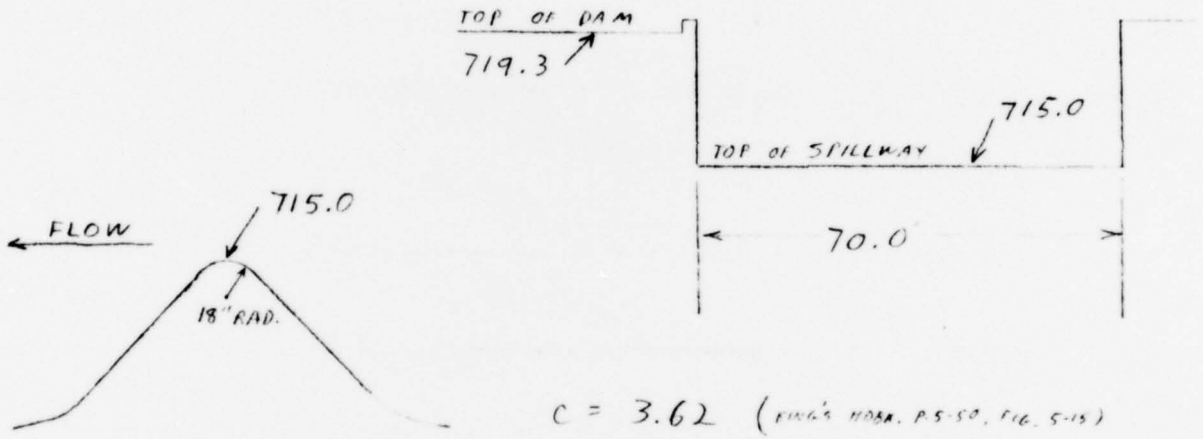
$= 3.14 \times 2.5^2/4$

$= 4.9$

$H = 715 - 676.67$

$= 38.33'$

SPILLWAY CAPACITY



$C = 3.62$ (KING'S HDBK. P 5-50, FIG. 5-15)

$L = 70.$

$H = 719.3 - 715$

$4.3'$

$Q = C L H^{3/2}$

$= 3.62 \times 70 \times (4.3)^{3/2}$

$= 2259$ CFS

USE 2250 CFS

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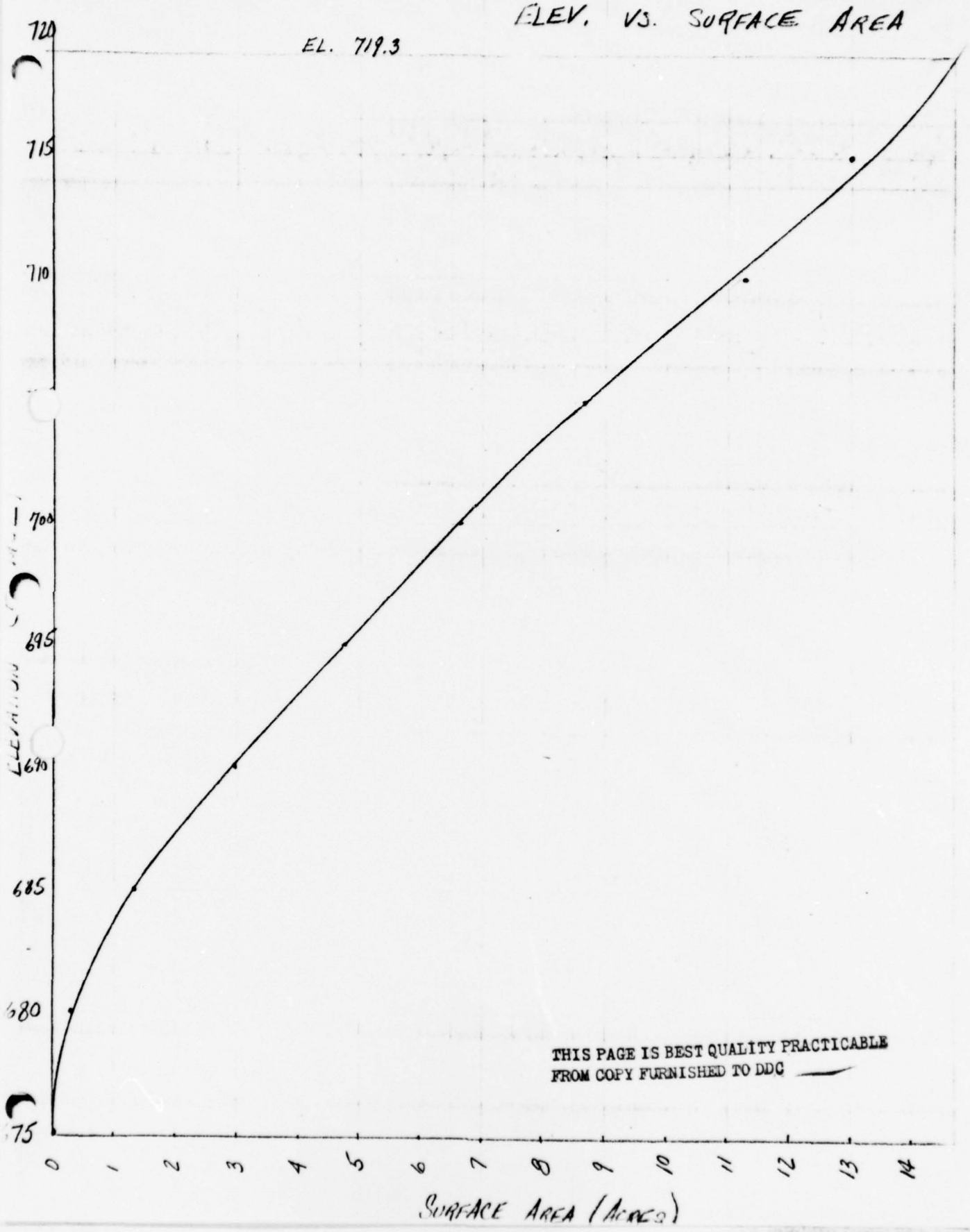
1960 W.R.A. REPORT LISTS SPILLWAY CAPACITY AS 2100 CFS.

BY DATE BERGER ASSOCIATES SHEET NO. 3 OF
CHKD. BY DATE FISHING CREEK DAM PROJECT D7350
SUBJECT DAM INSPECTION FREDERICK, MD.

ELEV. VS. SURFACE AREA



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BY DJR DATE 6/26/78 | BERGER ASSOCIATES | SHEET NO. 4 OF 8
CHKD. BY [illegible] DATE 7/5/78 | FISHING CREEK DAM | PROJECT D7350
SUBJECT DAM INSPECTION | FREDERICK, MD.

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STORAGE (ACRE FT.)

EL 675 → 680...

$$\frac{(.32 + .01)\ \text{ACRES}}{2} \times 5\ \text{FT.} = .825\ \text{AC-FT} \leftarrow$$

EL 680 → 685...

$$\frac{(1.32 + .32)}{2} \times 5 = 4.1\ \text{AC-FT} \leftarrow$$

EL 685 → 690...

$$\frac{(2.97 + 1.32)}{2} \times 5 = 10.725\ \text{AC-FT} \leftarrow$$

EL 690 → 695...

$$\frac{(4.73 + 2.97)}{2} \times 5 = 19.25\ \text{AC-FT} \leftarrow$$

EL 695 → 700...

$$\frac{(6.62 + 4.73)}{2} \times 5 = 28.375\ \text{AC-FT} \leftarrow$$

EL 700 → 705...

$$\frac{(8.67 + 6.62)}{2} \times 5 = 38.225\ \text{AC-FT} \leftarrow$$

EL 705 → 710...

$$\frac{(11.27 + 8.67)}{2} \times 5 = 49.85\ \text{AC-FT} \leftarrow$$

EL 710 → 715...

$$\frac{(13 + 11.27)}{2} \times 5 = 60.675\ \text{AC-FT} \leftarrow$$

EL 715 → 720 . . .

$$\frac{(14.98 + 13)}{2} \times 5 = 69.95 \text{ AC-FT}$$

ELEVATION	STORAGE (ACRE-FT)
720	281.975
715	212.025
710	151.35
705	101.5
700	63.275
695	34.9
690	15.65
685	4.925
680	.825

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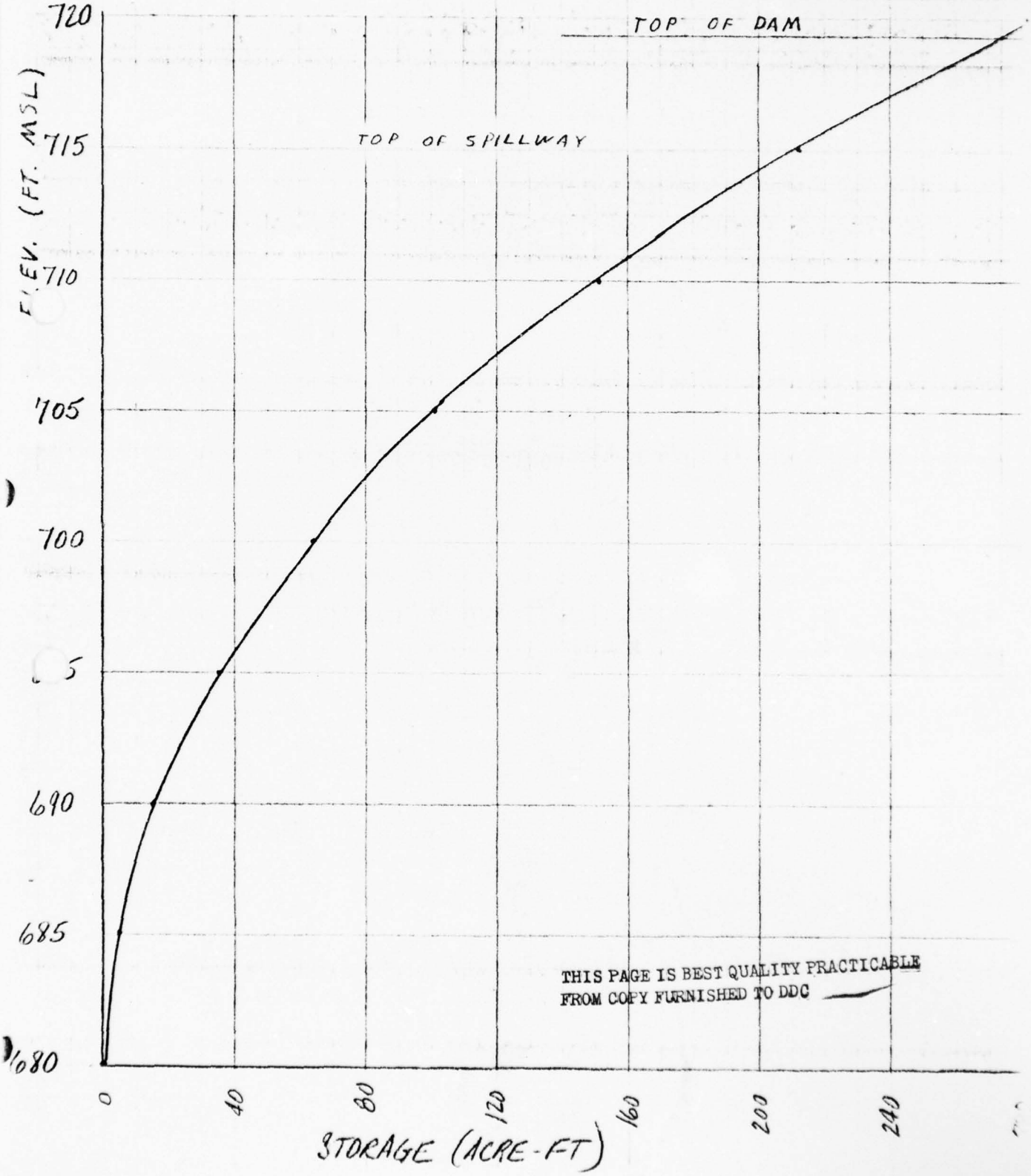
SUBJECT DAM INSPECTION SH. #6 OF 8

APPROXIMATE RESERVOIR STORAGE CURVE



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PMF

PMF OBTAINED FROM CORPS OF ENGINEERS, BALTIMORE DIST
COMPUTED FOR GAGE AT UPSTREAM END OF
RESERVOIR, DA. = 7.1 SQ. MI.

PEAK Q = 12200 CFS
RUNOFF = 32.72 IN.
= 12400 AC-FT

$$\frac{\text{MAX. DISCHARGE}}{\text{PEAK INFLOW}} = \frac{2250}{12200} = .184$$

$$\frac{\text{REQ'D. RES. STORAGE}}{\text{VOL. OF INFLOW}} = .816$$ FROM C. OF E. SHORTCUT METH

REQ'D. RES. STORAGE =
.816 × 12400 = 10100 AC-FT.

AVAILABLE STORAGE BETWEEN 715 AND 719.3

274 - 212 = 62 AC-FT.

ONE HALF PMF

Q = 12200 / 2 = 6100 CFS
RUNOFF = 12400/2 = 6200 AC-FT

$$\frac{\text{MAX. DISCHARGE}}{\text{PEAK INFLOW}} = \frac{2250}{6100} = .369$$

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BY RLS DATE 1/15/78 **BERGER ASSOCIATES** SHEET NO. 6 OF 6
CHKD. BY DATE PROJECT
SUBJECT FISHING CREEK DAM

REQ'D. RES. STORAGE / VOL. OF INFLOW = .631 FROM SHORTCUT METHOD

REQ'D. RES. STORAGE =

.631 X 6200 = 3912 AC-FT.

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APPENDIX C

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Weaverton Quartzite.

Lithology: The Weaverton Quartzite as a whole is a complex of metamorphosed, interbedded sandstones and shales. The lower member of the formation, at the Fishing Creek Dam, consists of thin bedded, light gray quartzite, interbedded with yellowish brown phyllite. The principal minerals are quartz, muscovite and chlorite. The cementing material of the quartzite is quartz. At least two generations of cleavage are usually present, and bedding is often obscure in the phyllites.

Structure

Catoctin Mountain is the eastern limb of a large, complex anticline known as the South Mountain Fold. Locally the beds are thrown into a series of right, overturned folds. The beds at the site strike about N5°E and dip 45° to 85°E. Flow cleavage strikes about N15°E and dips an average of 50°E. Fracture cleavage dips to the northwest, 25° to 75°. There is a dominant trend of fracture traces which strike about N75°N. Fishing Creek is controlled by this set of fractures at the site.

Overburden

The overburden in the area consists of talus and colluvium derived from the weathering, and downslope movement of the bedrock. Some alluvium is present in the stream valley. Logs of test pits indicate clay to 35 feet on the left side (looking upstream) and 18 feet on the right.

Aquifer Characteristics

The Weaverton is composed of rocks which are essentially impermeable and ground water movement in the bedrock is almost entirely along fractures, particularly on fracture cleavage and joints. The lack of soluble minerals preclude the possibility of widening of fractures by continued ground water movement. The principal zones of ground water movement appears to be on the N65°W fractures which controls most of the major drainage lines in Catoctin Mountain.

Discussion

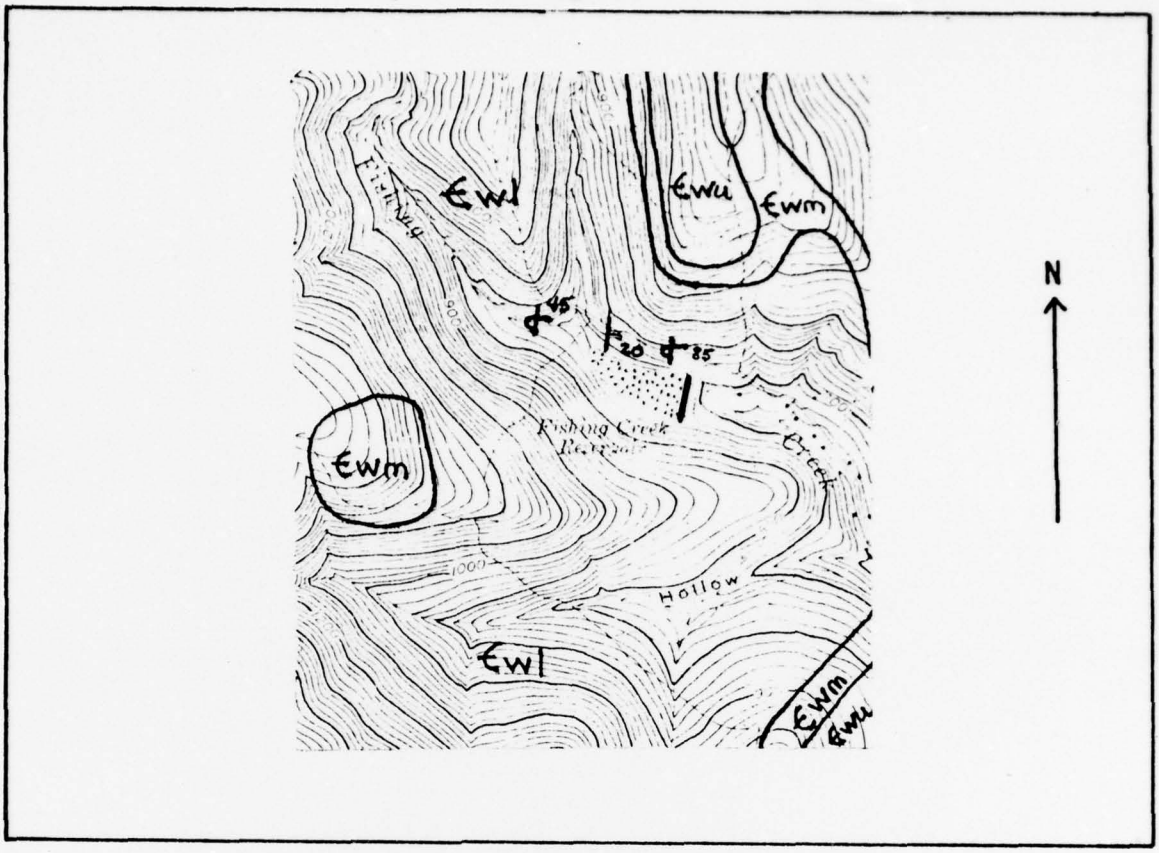
The foundation concrete cutoff wall was apparently dug only a short distance into bedrock. There is, therefore, the possibility of some leakage under the dam along the N65°W fracture zone, which is nearly perpendicular to the dam axis. There is, however, little likelihood of widening of the factures by continued ground water movement.

Sources of Information

1. Whitaker, John C. (1955) "Geology of Catoctin Mountain, Maryland and Virginia". Bulletin of the Geological Society of America, Vol. 66, p.436 - 462.

2. Logs of Test Pits in File.

Geologic Map - Fishing Creek Reservoir Area



(geology from Whitaker, 1955)

KEY

Ewu	Weverton quartzite-upper member	↾	strike and dip
Ewm	Weverton quartzite-middle member	↾	stike and dip of overturned bed
Ewl	Weverton quartzite-lower member		

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SCALE 1:24000

1 0 1 MILE

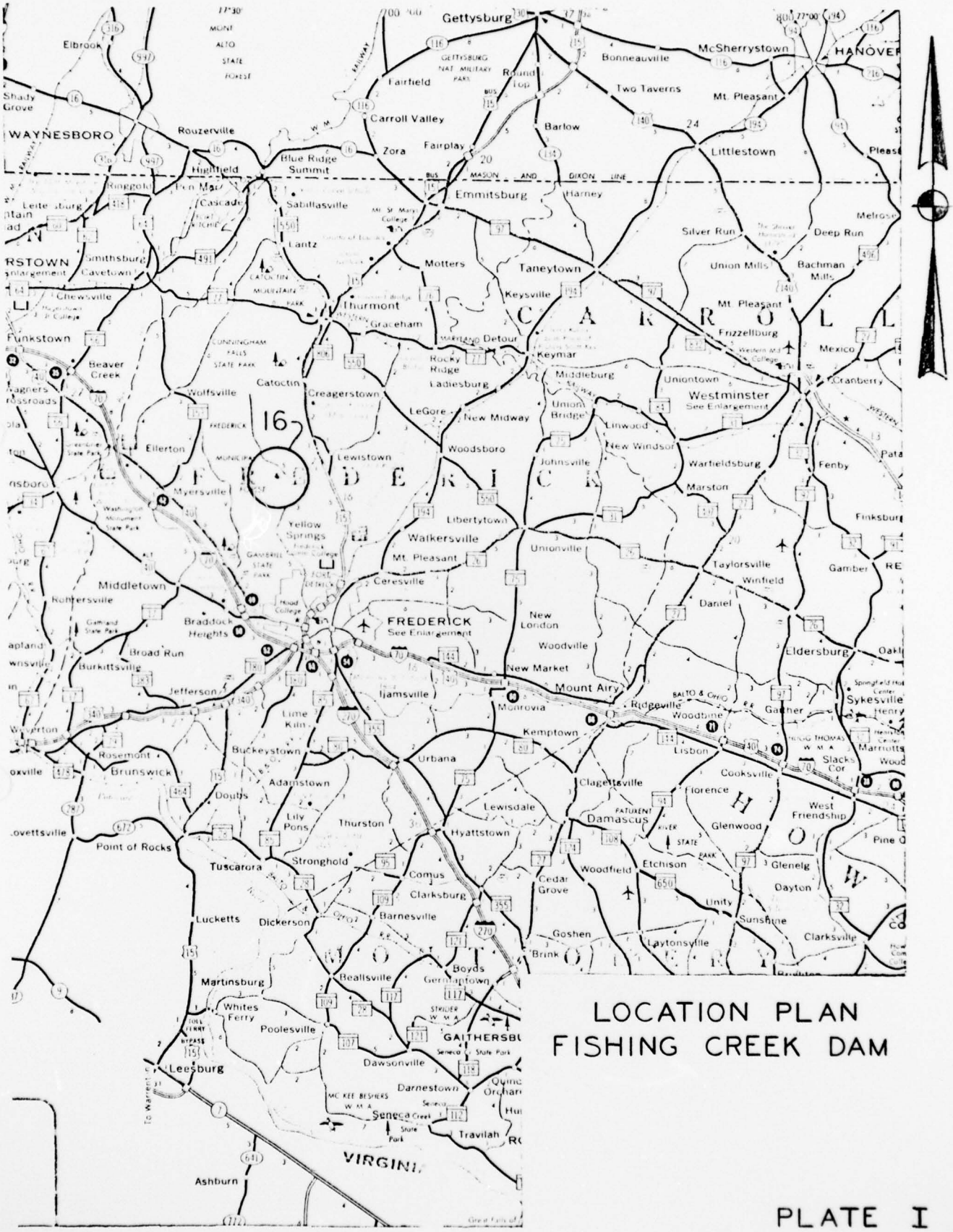
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

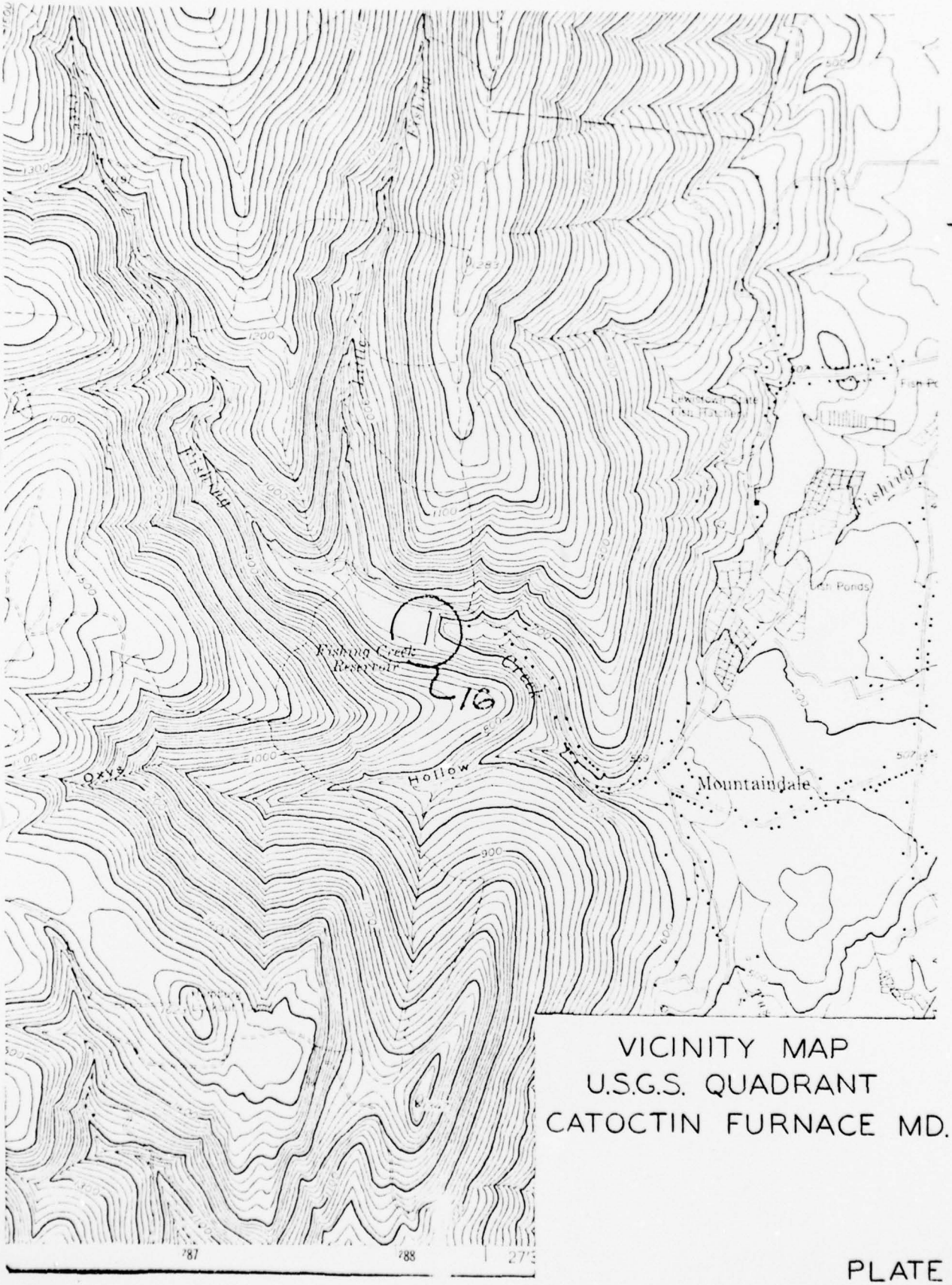
APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS



LOCATION PLAN
FISHING CREEK DAM

PLATE I



VICINITY MAP
U.S.G.S. QUADRANT
CATOCTIN FURNACE MD.

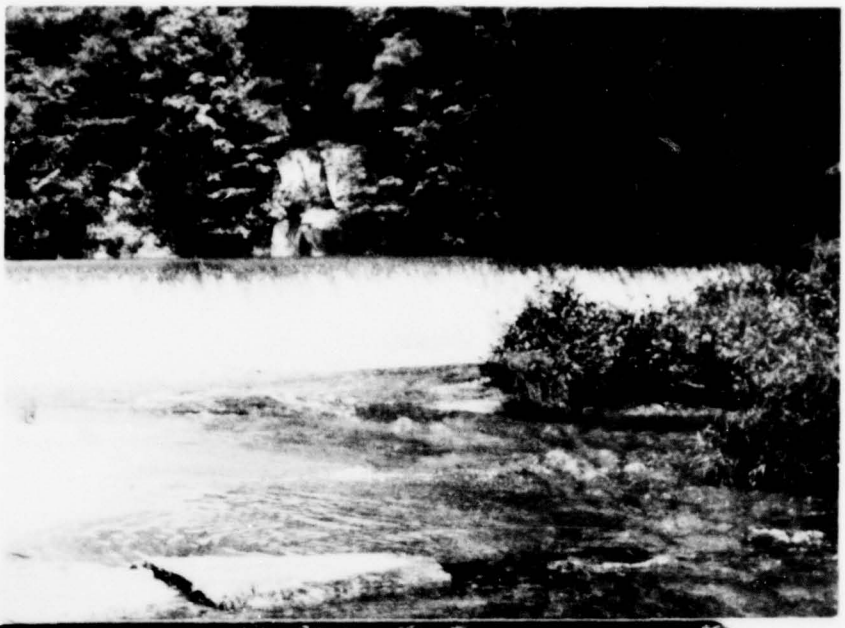
PLATE II

RESERVOIR AND
CONTROL TOWER

CONDUIT

'LEAKAGE" AT
TOE OF DAM

PLATE III



SPILLWAY WEIR

SPILLWAY

SPILLWAY

PLATE IV

DOWNSTREAM CHANNEL

TYPICAL UPSTREAM IMPOUNDMENT

PLATE V

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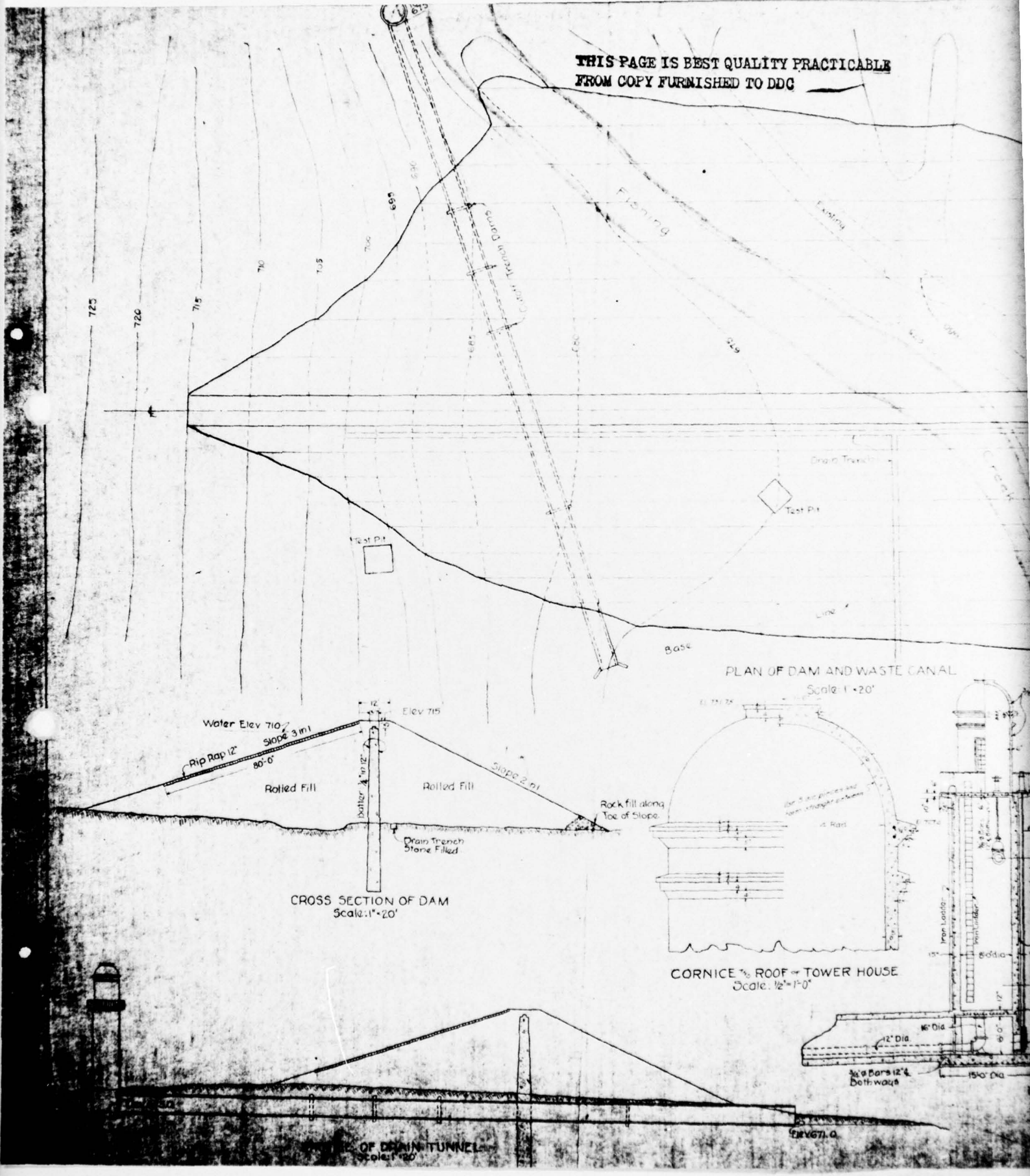
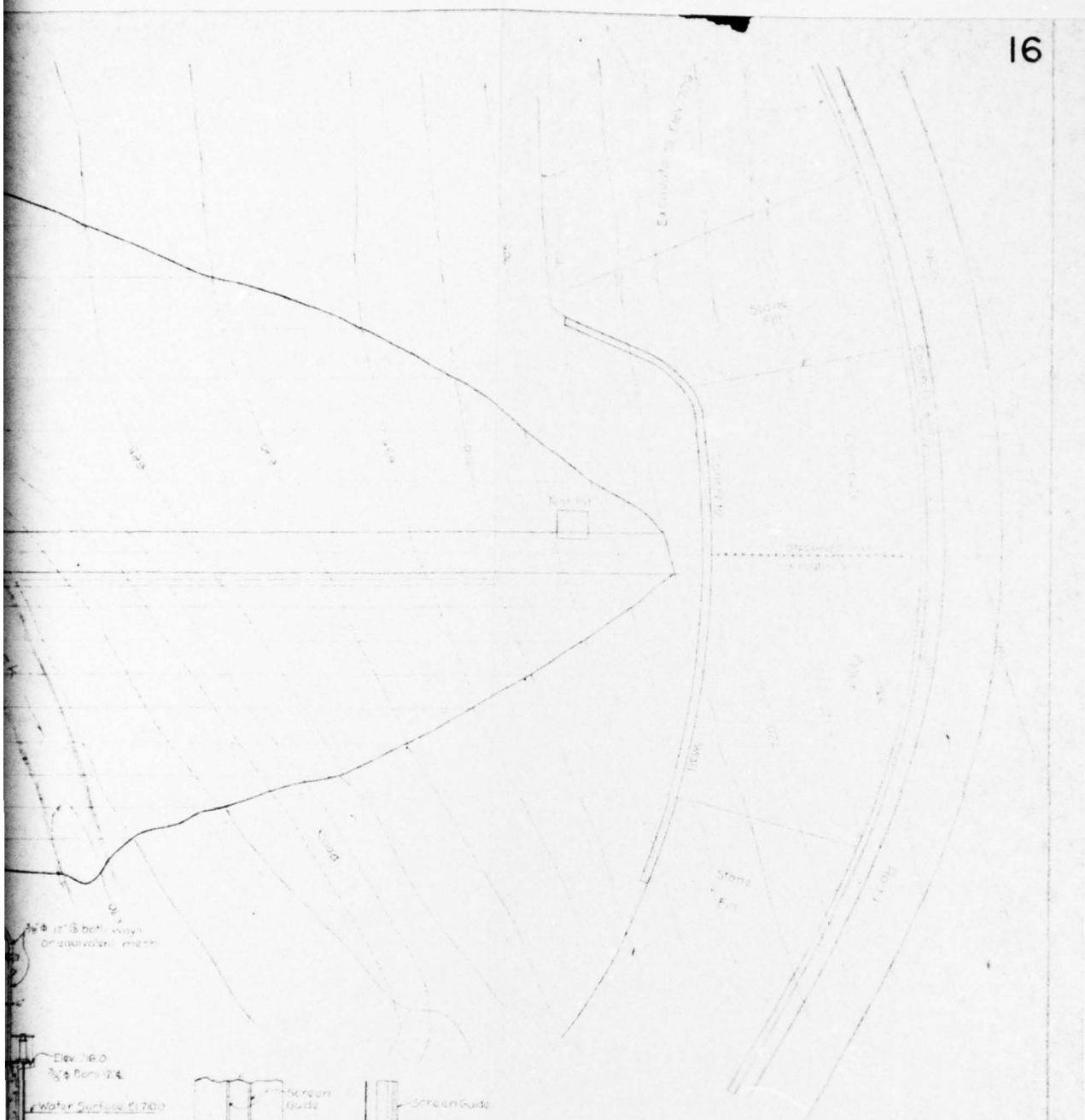


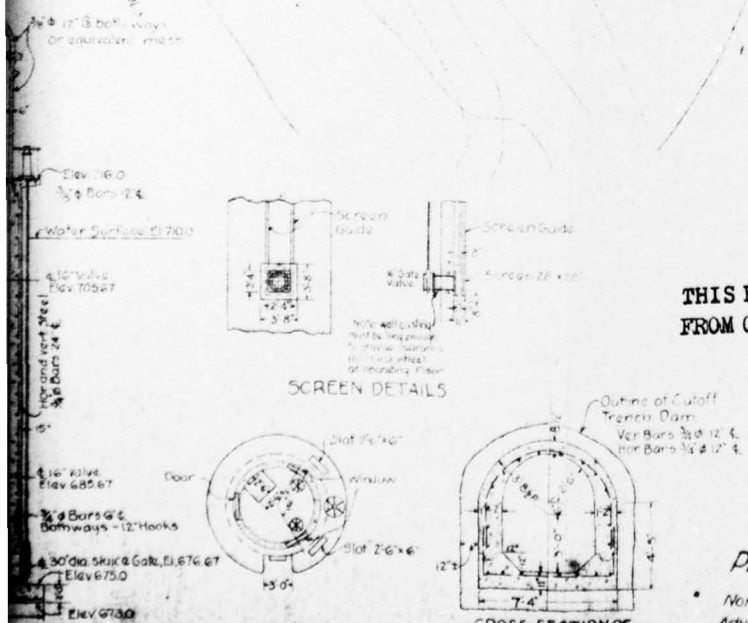
PLAN OF DAM AND WASTE CANAL
Scale: 1"=20'

CROSS SECTION OF DAM
Scale: 1"=20'

CORNICE & ROOF OF TOWER HOUSE
Scale: 1/2"=1'-0"

ELEVATION OF DRAIN TUNNEL
Scale: 1"=20'





SCREEN DETAILS

INTAKE TOWER DETAILS
Scale: 1/8"=1'-0"

CROSS SECTION OF DRAIN TUNNEL
Scale: 1/4"=1'-0"
Concrete 0.889 ± Cu yds per ft.
Steel 750# ±

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FISHING CREEK DAM
CITY OF FREDERICK, MARYLAND

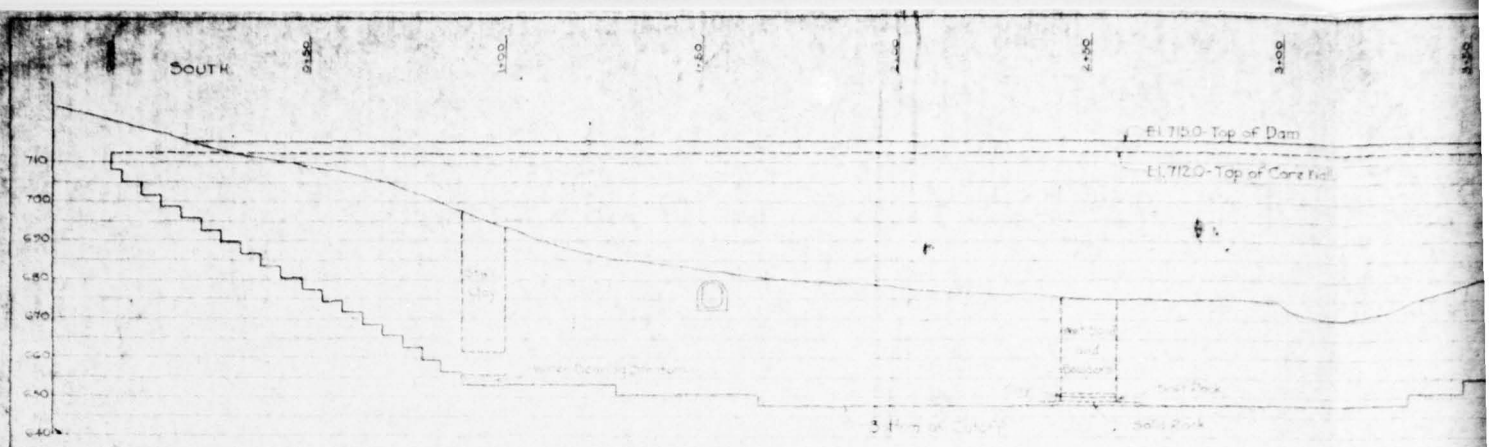
PLAN AND DETAILS OF EARTHFILL DAM

Norton Bird and Whitman, Advisory Engineers, Munsey Building, Baltimore, Md.
Emery C. Cram, City Engineer, Frederick, Md. Supervisory Engineer.

Scales as shown
October 25, 1923

Sheet No. 3

PLATE VI



SECTION ON AXIS OF DAM
Scale: 1"=20 Ft.

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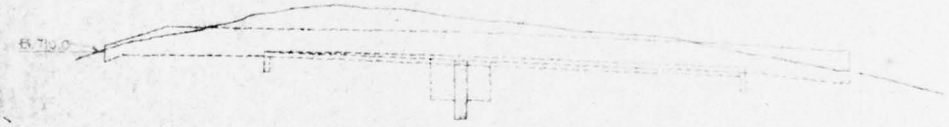
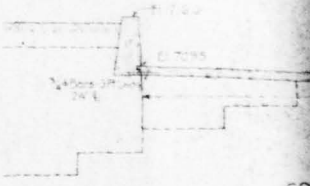
PLAN SHOWING THICKNESS OF CORE WALL AT E
Scale: 1" = 20 Ft.



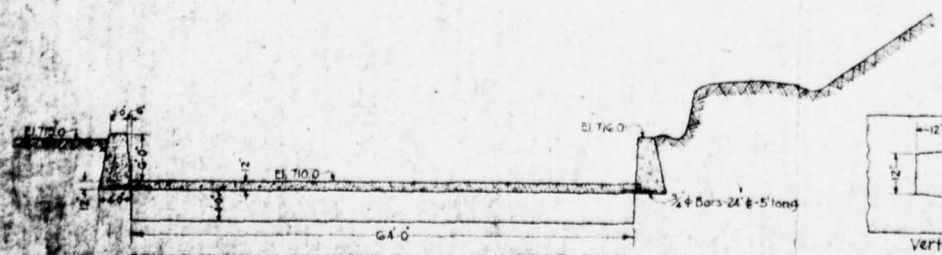
PROFILE OF SOUTH WALL OF WASTE CANAL
Scale: 1" = 20 Ft.



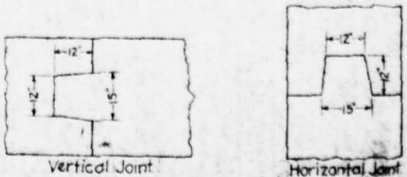
CR

PROFILE OF NORTH WALL OF WASTE CANAL
Scale: 1" = 20 Ft.

CROSS SECTION OF



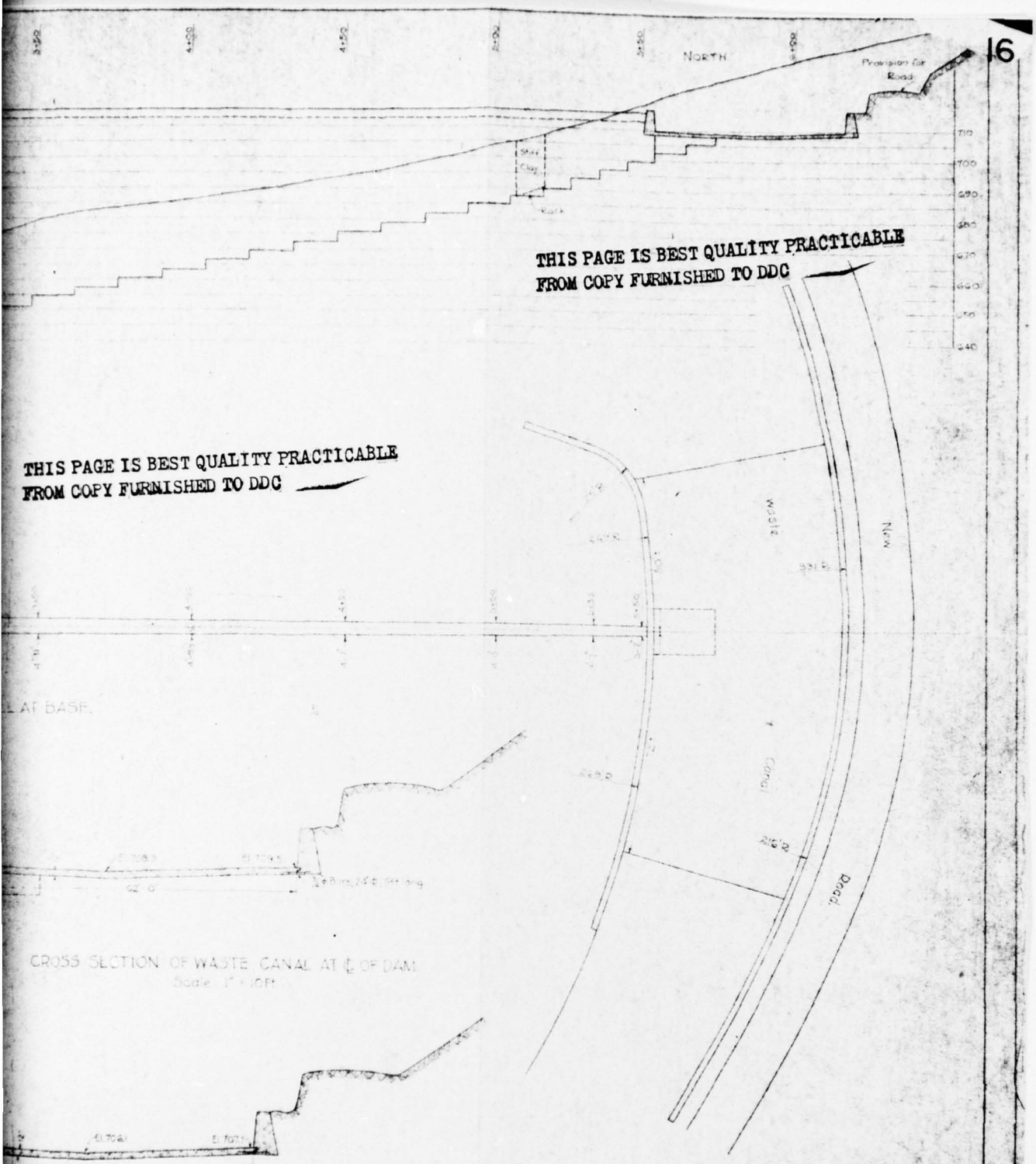
CROSS SECTION OF WASTE CANAL AT UPPER END
Scale: 1" = 10 Ft.



KEYS IN CORE & CUT-OFF WALL.

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC



L AT BASE.

CROSS SECTION OF WASTE CANAL AT ℄ OF DAM.
Scale: 1" = 10 Ft.

ON OF WASTE CANAL AT LOWER END.
Scale: 1" = 10 Ft.

FISHING CREEK DAM
CITY OF FREDERICK, MARYLAND.

PROFILE ON DAM AXIS & WASTE CANAL DETAILS

Norton Bird and Whitman, Advisory Engineers, Munsey Building, Baltimore, Md.

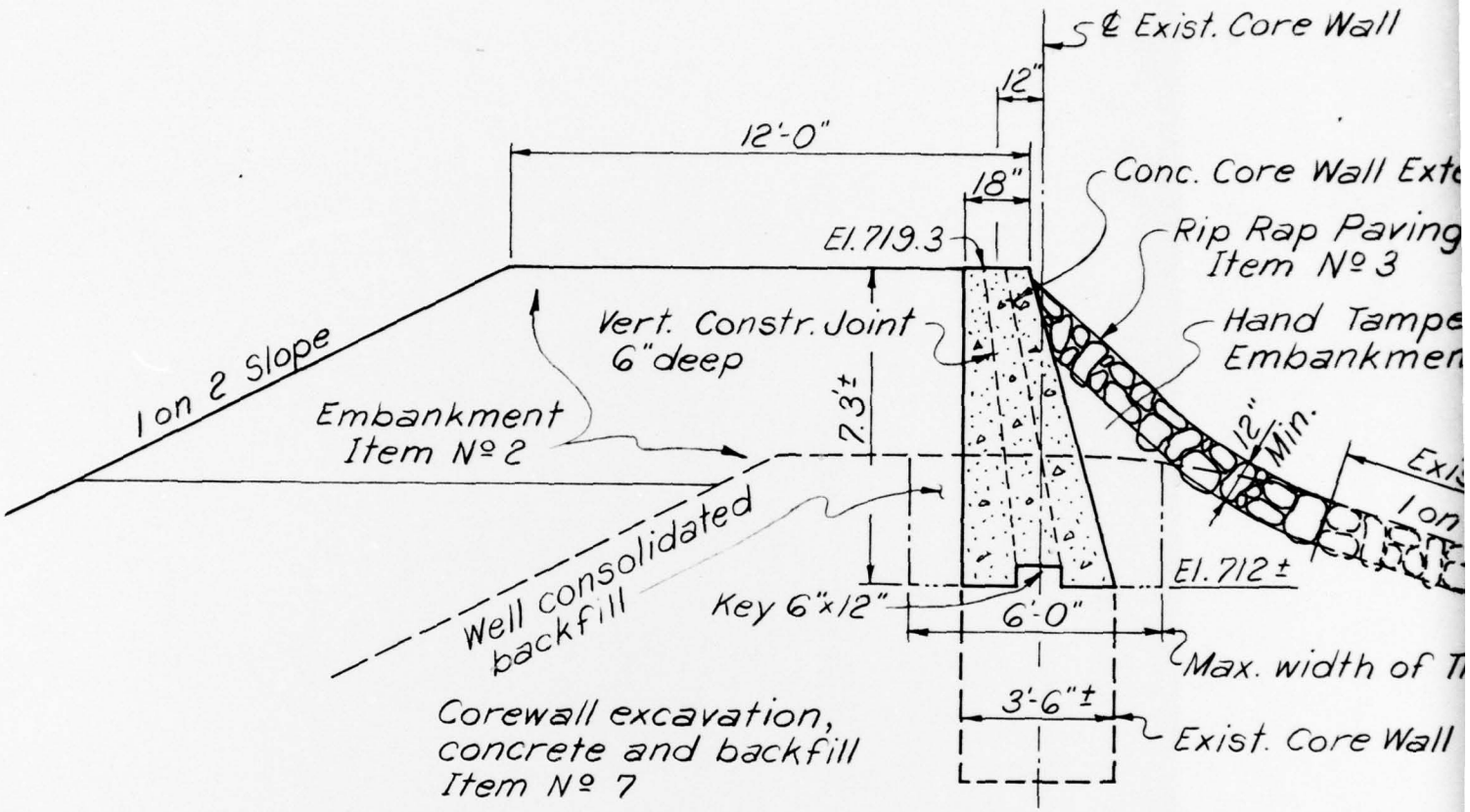
Emory C. Crum, City Engineer, Frederick, Md. Supervisory Engineer.

Scales: as shown. October 25, 1928.

Sheet No. 4.

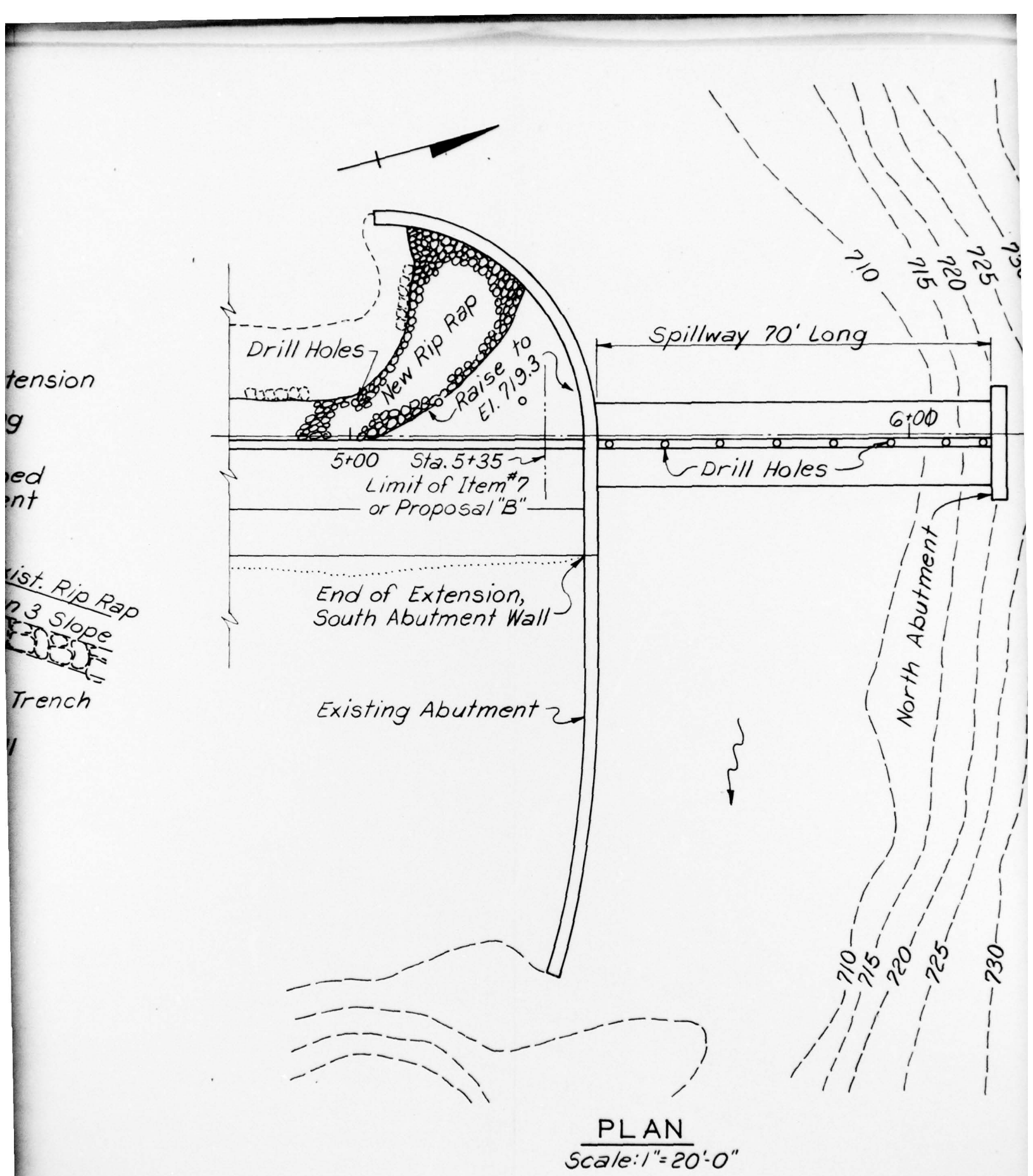
PLATE VII

U.S. v. 30219



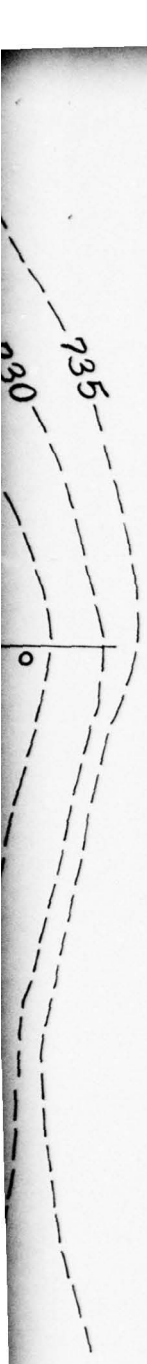
NON-OVERFLOW SECTION

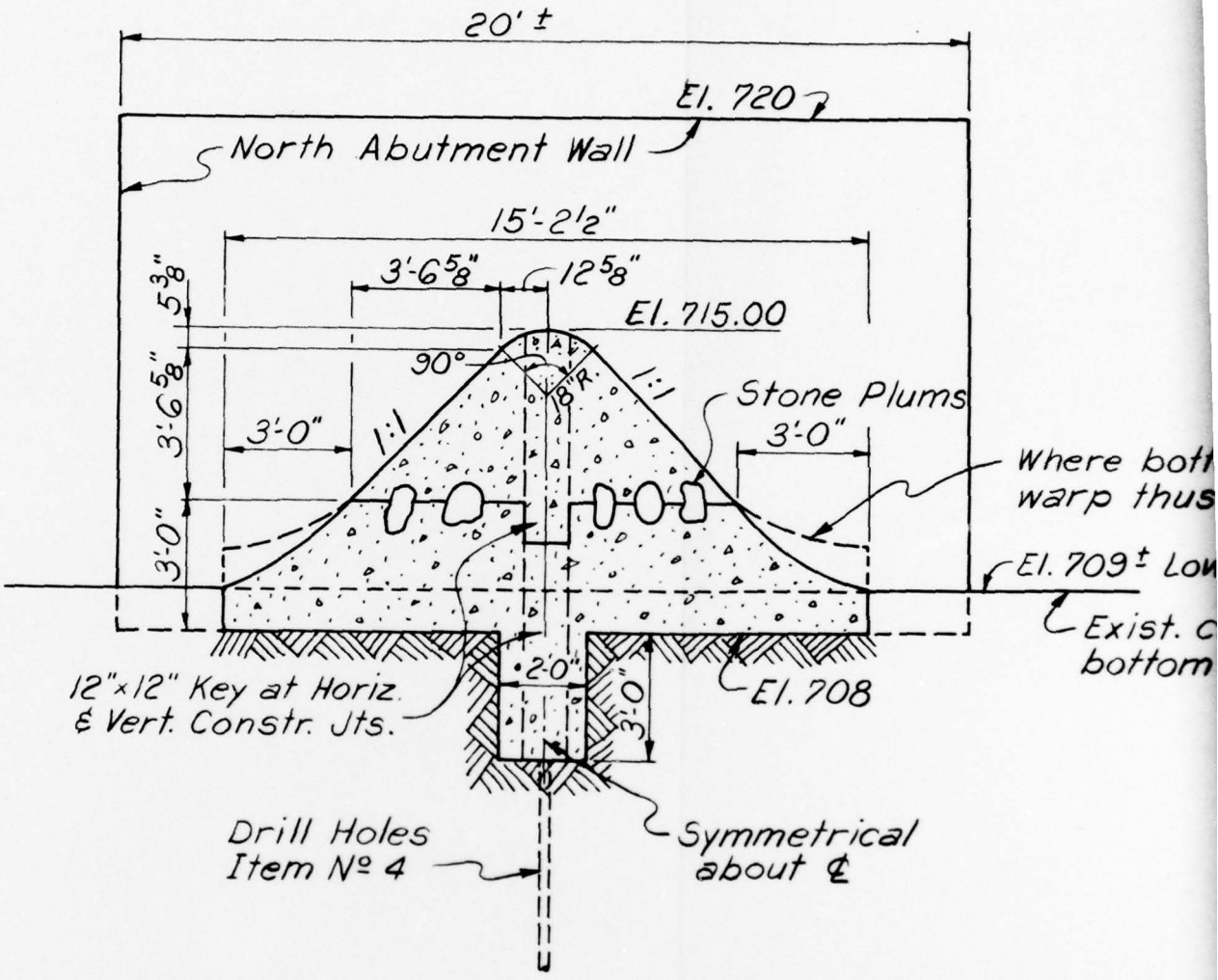
Scale: 1/4"=1'-0"



PLAN

Scale: 1" = 20'-0"





SPILLWAY SECTION

Scale: ¼"=1'-0"

CITY

O

3

ttom is higher
is

ow Point

canal
n-Rock

FISHING CREEK DAM
Y OF FREDERICK MARYLAND

PLAN & DETAILS
F 1933 MODIFICATIONS

PLATE VIII 4